# consulting engineer

April 1955

ALAN G. STANFORD, vice president of Robert and Company Associates, Architects and Engineers, Atlanta, Ga., as a past-president of both the National Society of Professional Engineers and the National Council of State Boards

*—Continued on page 6*

*The Consulting Engineer's Professional Magazine*

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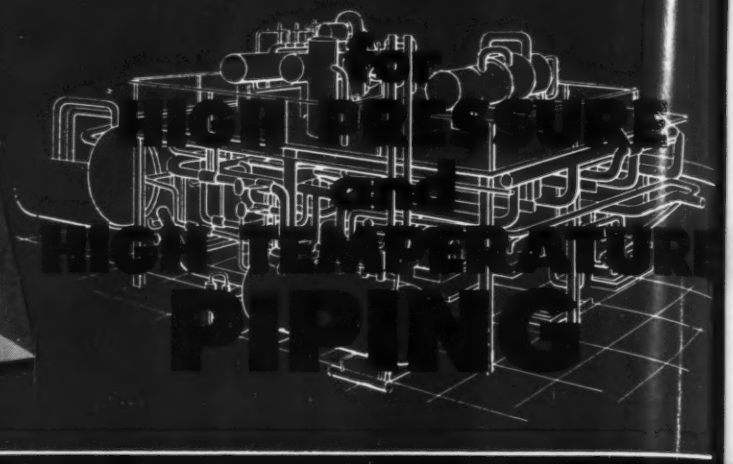


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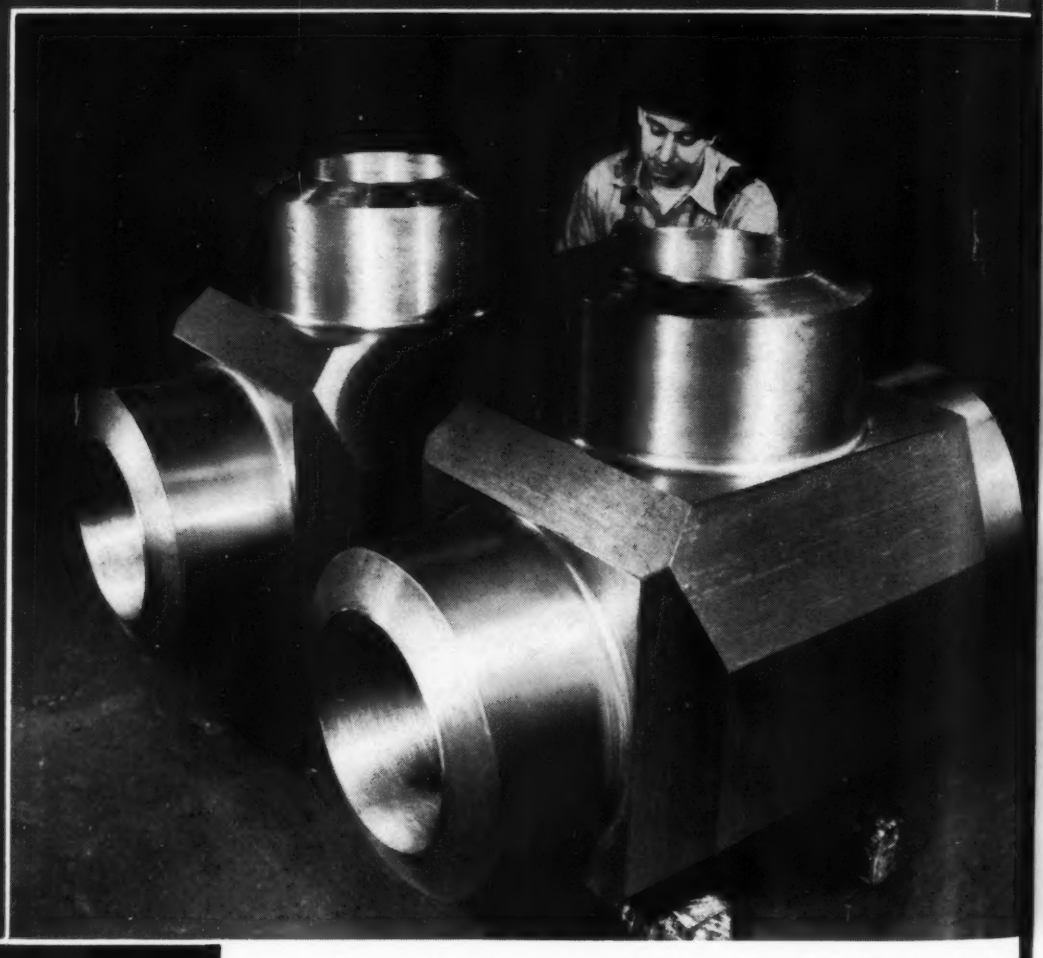

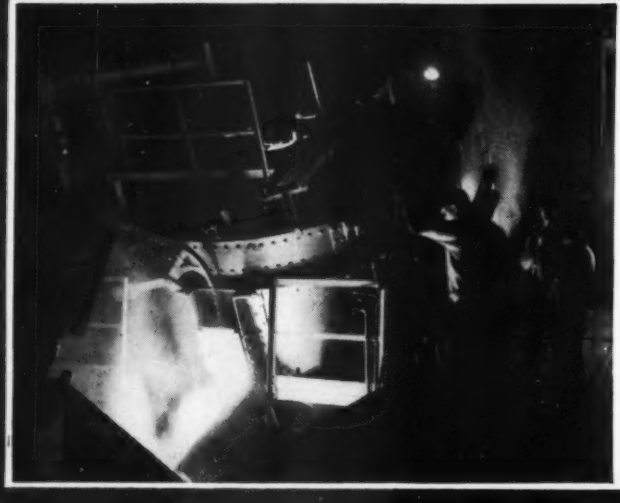

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**A. G. Stanford**

*—Starts on front cover*

of Engineering Examiners probably knows as much about the problems of professionalism as any other engineer in the country. More important, he has some solutions to these problems. "We are now," says Stanford, "still in a period of transition, a period of metamorphosis from a trade to a profession. This change depends for its progress upon one vital requirement of professional operation—registration. Registration must be studied from two points of view—the legislative aspect, and the aspect of the individual engineer."

Stanford thinks that there is progress being made from both directions, but "there is still a long way to go." A most immediate need is for a more vigorous and effective enforcement of the registration laws now on the books of every state and territory. These laws, as they now stand, are generally satisfactory, even though imperfect, laws. Unfortunately, our laws permit exemption from the requirements of the Registration Acts of many persons engaged in engineering work.

While our engineering registration laws prescribe penalties for the law breakers, Stanford thinks that, only through the combined vigilance of all registered engineering practitioners in policing such practices, coupled with closer observance of the provisions of these laws by the many agencies of our municipal, county, and state government, can the real purpose of such laws in protecting the health, safety, and life of the public against the work of shysters and incompetents be realized.

### Corporate Practice

"Another aspect of the registration laws that is receiving more attention at the present time than perhaps it deserves is the question of corporate practice. Some states will let corporations practice engineering as consultants. Some will not. Now, Robert and Company Associates is a corporation—a closed corporation—but still a corporation. Under the laws of the State of Georgia, (or any other state, for that matter) we are just as responsible for our work as any individual engineer or partnership. We can be sued or fined, and the principals of this corporation could be punished individually if found criminally liable in connection with engineering work we had done. This idea that some people have that the officers are not responsible for the acts of the corporation just is not true.

"Furthermore, there was certainly no change in our ethical thinking or professional practice when we changed from a partnership to a corporation. Each engineer in this company whether an officer or not, is as zealous as ever of his reputation.

"Some confusion also has existed as to the position of the National Society of Professional Engineers with respect to the objectives of its Member State Society in New York. You should understand that the National Society has never supported the position taken by the New York State Society in opposing corporate practice. NSPE has very properly taken the position that each State Society has the perfect right and freedom to act in any way it sees fit with regard to laws of its own state. It is sort of like 'opposing what you say but standing up for your right to say it.' "

### The New York Case

Stanford thinks that the New York State Society of Professional Engineers was wrong last year in fighting corporate practice. He agrees more closely with the position of the Committee on Engineering Laws, a group formed to lobby in favor of a revision of the law to permit corporate practice, but with ample provision for safeguarding the public against incompetent or unscrupulous practice.

"Of course," Stanford says, "the law should require the principals of any engineering organization to be registered. Now, I am glad to say, the NYSPE has more or less come around to this way of thinking. However, I understand, the New York Society wants to require every officer of an out-of-state corporation to be registered in New York before being permitted to practice in that State. That seems to be going too far. Suppose that our Company had the opportunity of handling engineering work in New York. We would naturally expect to have the officer of the Company who would be officially in responsible charge registered in that state, and we would expect all engineers who might have any responsibility for portions of the work, to be registered in Georgia. Why should we also be required to have every one of our principals registered in New York, when most of them would have nothing whatsoever to do with that project?

"Those are the kind of things I mean when I say that there is still work to be done from the legal aspect of registration.

"Then, there is the equally important aspect of registration from the individual engineer's point of view. There are only about 180,000 engineers registered in this country. Therefore, according to law and to my way of thinking, there are only 180,000 engineers. Any man not registered simply should not use the title of engineer. He may be working in the engineering field, but legally he is no more an engineer than an unregistered medical technician is a medical doctor. Registration is absolutely essential to professional engineering recognition.

"I believe that I know many of the problems involved. I helped draft the Registration Law for

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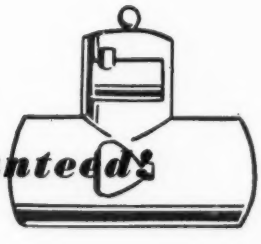

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the State of Georgia some eighteen years ago. I was appointed to the first Board of Registration in that State and am still serving on that Board. My rather extensive association with the National Society of Professional Engineers and with the National Council of State Boards of Engineering Examiners enables me to see this thing from a national as well as a state point of view. We are going to have to make continual changes, to strengthen and make more uniform our registration laws, and to bring about more widespread recognition of the professional aspect of engineering practice.

"We should find some way to move young graduates from Engineer-in-Training status to full registration along more positive and effective routes. I would like to see reports submitted at regular intervals to the Registration Board on the sub-professional work being done by each Engineer-in-Training. These reports would be sent to the Board by the employer and more preferably by the engineer under whom the young man would be working. By keeping up with the young graduate and treating his first few years out of school as a sort of internship, all able young men could be brought to full registered status as quickly as possible and with little confusion. And we must get the idea over in college that a man becomes an engineer not on graduation but on registration.

### Engineering Unity

"You cannot discuss the professional aspects of engineering without bringing in 'Unity.' There is no question but that either we must have some kind of unity organization or a unified program among existing groups if we wish to eliminate the useless duplication of effort for advancing the recognition of both the scientific and the professional features of engineering. As a Fellow of American Institute of Electrical Engineers, no one appreciates more than I the importance of the technical societies and their contribution to the progress of engineering. In fact, I think they are more responsible than any other single factor for the great industrial and scientific progress this country has made.

"The trouble is that every one of the Founder Societies thought it necessary to insert in their early constitutions broad statements about advancing the 'profession' as well as advancing the 'science' of engineering. Provision for these broad objectives was quite logical in the early days of these societies. But today, because of the tremendous technological advancements in all of the major branches of engineering, the separate Founder Societies just are not set up to proficiently advance the strictly professional aspects of engineering practice which, by their very nature, are largely the same for all branches. Their constitutional structure, and the structure of Engineer's Joint Council, is ideal for advancing the sciences, year by year. But this structure inherently prohibits quick and effective action on professional matters. For example, if some State Legislature or the United States Congress were to propose some law that would put all of a certain branch of engineers out of business, if would likely be months before EJC could get its constituent Societies to agree on proper action. The State Legislature or the Congress could have acted and gone home long before the engineer's story was heard. On the other hand, the Executive Committee of the State or National Society of Professional Engineers could act in a matter of hours, and we could have professional legal aid from NSPE immediately. We could have our story ready for presentation by the time the bill reached a committee.

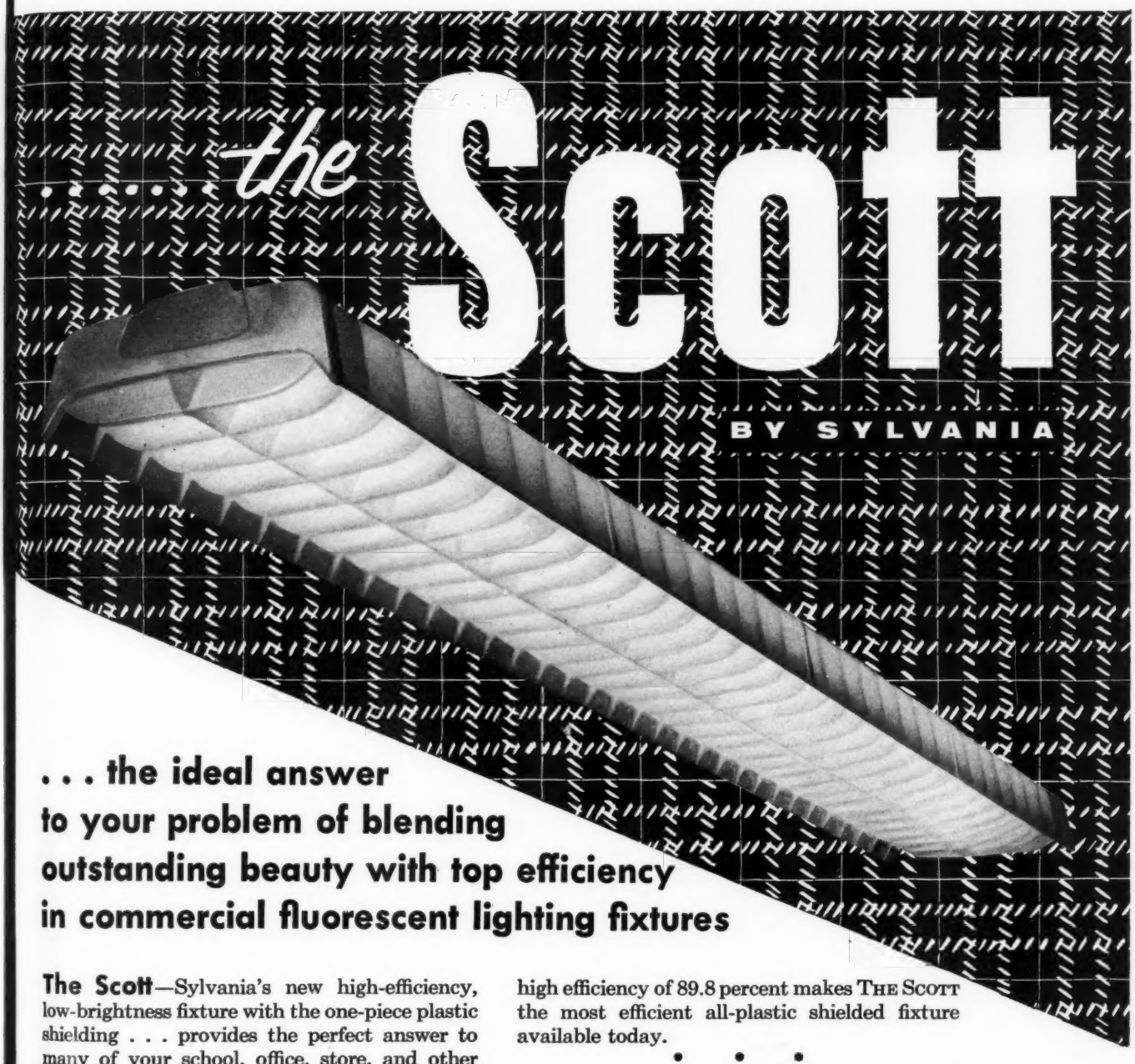
### Long-Standing Prejudices

"On the other hand, experience has indicated that NSPE, as presently constituted, is not acceptable to many as a unity organization. Unfortunately there has been long-standing prejudice in many quarters which has made more difficult the solution of this problem. And EJC is now expanding with the obvious idea of trying to answer the demand for a unity group. However, I am firmly of the opinion that for the proper handling of professional problems, an individual member, grass-roots type of organization is mandatory.

"There will some day probably be a compromise . . . some sort of amalgamation (although I do not like the word). Calm and rational engineers will come up with a solution that will satisfy the great majority. It is possible, however, that being human beings, this great majority will not be satisfied, no matter how good the suggested organization, unless we find a new name for it. Too many strong NSPE men would refuse to go along with any organization that was called Engineer's Joint Council. Some EJC men seem even more adamant in refusing to associate themselves with National Society of Professional Engineers. Fortunately, many engineers are strong men in both camps. That is good.

"There is no reason to talk of NSPE lowering their admission requirements and taking in men who are not registered. NSPE is speaking in professional matters for engineers just as the AMA is speaking for doctors. There is no more reason for unregistered men to have a voice in the professional affairs of engineers (just because they work in the engineering field) than there is for nurses to have a voice in the activities of medical doctors.

"In time, these matters will be straightened out. In time, we will pass through this period of transition and come to a time when engineering is a universally recognized profession . . . a profession in which all its practitioners are registered as engineers, are represented by one professional society, and are working as members of technical societies interested in the advancement of applied science."

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# READERS' COMMENT

### Engineers' Unions

I was particularly interested in the article "Engineers' Unions Are Here" in the January issue. CONSULTING ENGINEER, unlike many engineers' publications, does not follow the insipid practice of always telling its readers what they want to be told. For some months now *Civil Engineering* has been publishing what must be termed sheer anti-union propaganda. There is seldom any attempt to discover facts, but simply an airing of prejudices and rationalizations about the horrors of unionism. From my personal contact with Junior members of the ASCE I know that this propaganda is missing the mark. It fails miserably to deal with the genuine issues involved.

I take issue with one point in Mr. MacDonald's article "The Economic Outlook—1955." He suggests that the minimum housing requirements are fairly well satisfied at present. Perhaps this is true in a purely economic sense, but the need for new housing in blighted metropolitan areas is as urgent now as ever. In my opinion, engineers should be vitally interested in this social problem as well as in the other aspects of urban redevelopment. In the words of the ASCE Code of Practice: "Public duty, as well as personal interest, justify the Engineer in advancing worthy public enterprises."

C. W. Griffin
Erlton, New Jersey

● WE OPPOSE THE IDEA OF UNIONS FOR ENGINEERS, BUT WE MUST FACE FACTS, "ENGINEERS' UNIONS ARE HERE."

### How Much Drafting?

I have read Mr. J. F. Lee's article, "How Long Should He Be on the Board?", and would say that I am in complete agreement with him, but I would not restrict his conclusions to consulting firms, as they are generally applicable in industry both for manufacturers and elsewhere. This whole problem relates somewhat to the question of "shortage" of engineers. If there is a shortage, it is not a shortage of engineers, but one of "engineering aids," since too many college graduates have been and still are used by industry in capacities which are very much on a subprofessional level. Mr. Lee's thinking is very close to my own. As a matter of fact, I have often referred by comparison to the medical profession in pointing out that I have never seen a physician who is employed as a nurse. If we learn not to use engineers as "nurses," we will soon find that we do not have a shortage.

Eric T. B. Gross, Professor
Illinois Institute of Technology
Chicago 16, Illinois

Concerning the article ["How Long Should He Be On the Board?"] written by Mr. John F. Lee, it was passed to a number of prominent engineers for their reaction. Here are some of the comments:

1st Engineer—"Poor fellow; he cannot see the forest for the trees."

2nd Engineer—"Don't pay much attention to it; it sounds like Sophomore dribble."

3rd Engineer—"Sounds as if he despises board work or has an inferiority complex and is taking this opportunity to strike back."

Personally I do not agree with the philosophy of the author as expressed in this article. Statistics indicate that two-thirds or more of any large project usually is "board work."

T. C. Brown
Professional Engineer
Raleigh, North Carolina

To recognize one's deficiencies is fully, if not more, important than to appreciate one's proficiencies. As one who never became even a passable draftsman, I am not quite in agreement with Professor Lee's point of view with respect to the need of drafting ability in young engineers as set forth in your February issue.

Few young engineers get responsible jobs immediately upon graduation. Skill with hands is part of the equipment which they have to offer prospective employers. In sanitary engineering, jobs which are open for the recent graduate usually call for the ability to perform one or more of the following manual functions: drafting, surveying, or lab work.

If the young man possesses only manual ability, it is of course true that he will continue to stay in that type of work where his skill is required. It is also true that he is likely to hold a job when economic conditions bring about unemployment among the more highly paid.

Fifty years ago, Professor Lee's thesis was widely acceptable by the students during my undergraduate days at M. I. T. I believed it then, but have learned its fallacies since. A good performer in any task, no matter how menial, attracts the attention of his supervisors, and in the right kind of organization advancement will follow if the young man has the other qualities which fit him therefor. If he isn't in the right organization, it is not important what his qualifications may be, for in such a case his merit may well go unrecognized and unrewarded.

Relative to manual skills, it may not be inappropriate to point out the manual skill of Leonardo da Vinci or the fact that William Barton Rogers, founder of M. I. T., learned from his father how to make laboratory apparatus. Perhaps this latter fact is responsible for the motto of M. I. T., "Mens et Manus."

Along the same lines, the quotation from Winston Churchill's "A Roving Commission" is interesting:

"When I am in the Socratic mood and planning my Republic, I make drastic changes in the education of the sons of well-to-do citizens. When they are sixteen or seventeen they begin to learn a craft and to do healthy manual labour, . . . It is only when they are really thirsty for knowledge . . . that I would let them go to the university. It would be a favor, a coveted privilege, only to be given to those who had either proved their worth in factory or field or whose qualities and zeal were pre-eminent."

E. Sherman Chase
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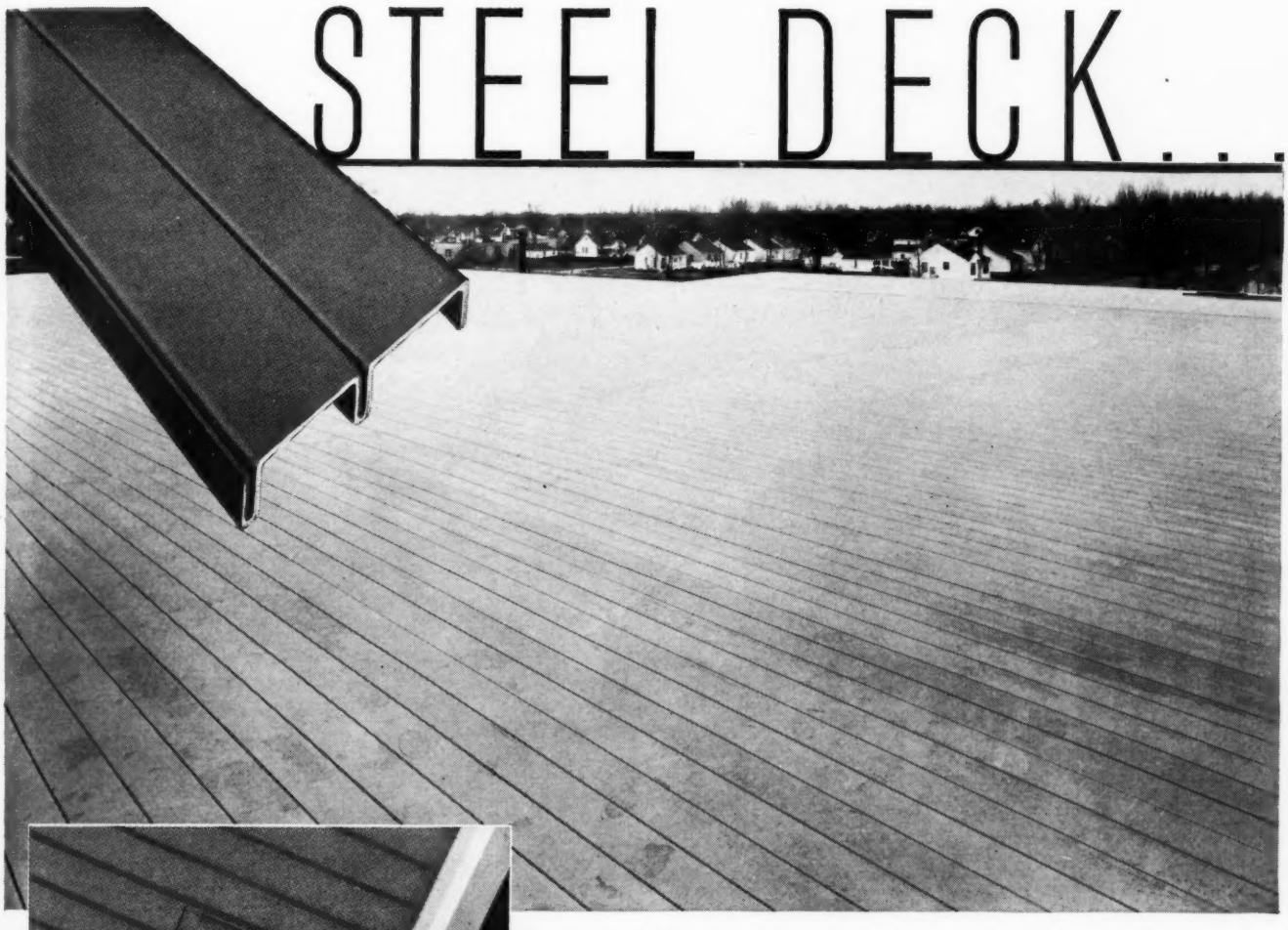

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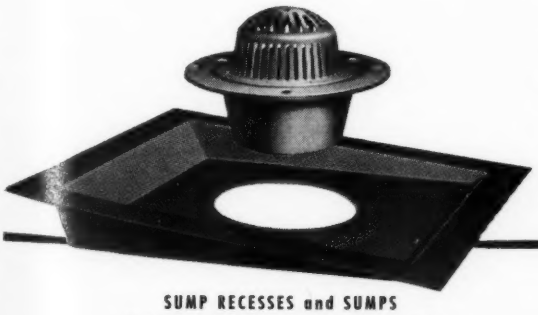

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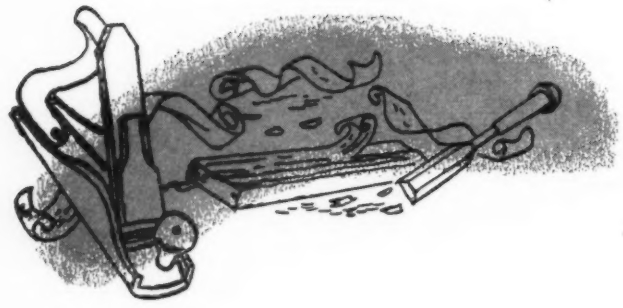

# SCRAPS & SHAVINGS

WE HAVE been spending the past few days reading the Yellow Pages (Red Book, to you big city folks) of telephone books from a number of cities. It is not hard to find many listings under one or more of the "Engineers" headings offering names of men or organizations who are not engineers.

The first fact to be gained from a study of these telephone books concerns the manner in which the several professions are listed. In every directory the lawyers are listed under either "Lawyers" or "Attorneys." The listing is not "Attorneys, Registered," or "Attorneys, Licensed," or "Attorneys, Admitted to the Bar," but just plain "Attorneys." Similarly, medical doctors are all listed under the simple heading, "Physicians & Surgeons, M.D."

Engineers are not handled in this logical and simple manner. In the Washington, D.C. telephone book, for example, we have "Engineers," "Engineers-Aeronautical," "Engineers-Air Conditioning," "Engineers-Chemical," "Engineers-Civil," just to go through A, B, and C. Perhaps this matter of classification even has its advantages, but nowhere in these listings is there any sign or statement to indicate which of these men and firms really are engineers as defined and registered by law and which are men and firms who just like the title "engineer."

The Philadelphia telephone book is the only one we have found that seems to recognize this situation. Here will be found a list "Registered Engineers." This listing is preceded by the statement:

> "Pennsylvania law requires engineering services be offered and performed only by registered engineers. The following Engineers are registered by the Commonwealth of Pennsylvania."

This listing is given under the seal of the Pennsylvania Society of Professional Engineers, but there is no indication as to whether this list is of all the registered engineers in Philadelphia who have business telephones or just those who are members of the PSPE. If this is a complete list of Philadelphia engineers who are registered, Philadelphia is indeed to be congratulated for having considered this question and hit upon a partial solution. The public in Philadelphia now has some way to tell from this public telephone directory whether they are getting hold of a real engineer when they call one on the basis of the Yellow Page listings. We would suggest that Philadelphia engineers go one step further: go to court and force all of the other "Engineers" in the book to stop listing themselves as engineers.

Compare this with the legal profession. If you were to go to the telephone company and ask them to list your name under "Lawyers," they would probably do so. They cannot check on every telephone subscriber to make sure you are just what you say you are. But your County Bar Association would be very interested. They would have you in court immediately, and it is safe to say that the court would order you to stop representing yourself as an attorney. If you refused, you would be in contempt of court, and what's more, in jail. You might use as your defense, "I did not claim to be a licensed attorney. I did not say I had passed the bar examinations and been admitted to the bar, but I am interested in the law, and I like to advise people. What's wrong with that?" You would be laughed out of court — and into jail.

Why should engineering be any different. Each state has registration laws to determine who is and who is not an engineer. Why, then, should any manufacturer or contractor or manufacturer's representative be able to list himself in a public place as an engineer just because he is willing to give "engineering" advice.

From a practical point of view, and as a first step, Philadelphia has the right idea. Registered engineers should be listed under a separate heading, and mention should be made of the fact that only registered engineers can offer engineering services under the law. This could be done in every city in the country merely by having the local engineering society call this condition to the attention of their telephone company. Most of these companies would be cooperative, for they realize that as publishers of the most commonly used public record, they have a duty to the public to be accurate within the limits of their power.

The next step would be to eliminate from under the various engineering headings all who are not in fact and under the law engineers. This thought we recommend for action to the Local Chapters of the State Societies of Professional Engineers and other local Societies of Engineers.

Here is a possibility for action that will immediately react to the best interest of the public and of engineering as a profession. ▲▲

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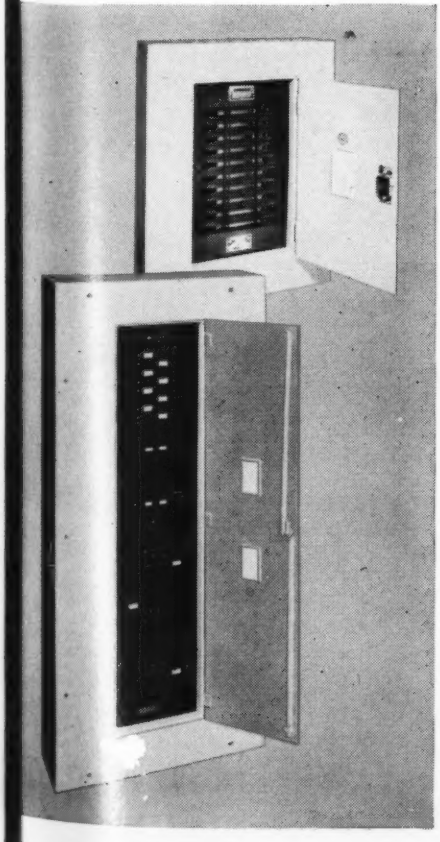

Safety and dependability of electrical service at the utilization level are assured in the Lankenau Hospital by the use of Westinghouse circuit breaker panelboards. Possible damage to operating equipment through short circuit or power overload is eliminated.

The great majority of service interruptions is caused by momentary overloads or short circuits. In these cases, the circuit breaker handle can be flipped back to the "On" position to restore service. However, if a sustained overload or short circuit occurs, it is impossible to close the circuit, since it is trip-free.

Type NLAB circuit breaker panelboards, shown at top left, provide positive circuit protection to all lighting and small appliance services in the hospital.

Type CDP convertible distribution panelboards, bottom left, serve other power loads in the building. These panelboards, with engineered convertible design built in, adapt easily to changing load requirements.

*Complete electrical installation by Harry F. Ortlip Co., Philadelphia, Pa.*

*The Lankenau Hospital, designed by Architect Vincent G. Kling, AIA, Philadelphia, was the nation's outstanding hospital of 1954. It received the National First Honor Award in Hospital Architecture from the American Institute of Architects.

DP-5013-E

YOU CAN BE SURE... IF IT'S Westinghouse

# the Legal Aspect

**MELVIN NORD**

**Consultant in Legal and Technical Problems**

**Registered Professional Engineer**

**Patent Attorney**

***. . . Master's Liability for Injuries to Servant***

ACCORDING TO the common law, an employee owes a duty of loyalty to his employer. The question then arises, "What duty does the employer owe his employees?" To some extent this is determined by the contract of employment, which will set forth certain rights of the employee such as compensation. In addition to these the law also imposes additional duties on the employer—sometimes by statute and sometimes by common law.

One of the main questions in this field is the extent of the employer's liability for injuries suffered by his employees.

### Founded on Negligence

According to the common law, an employer is not an insurer of the safety of his employees; that is to say he is liable only if he is at fault. His fault may either be intentional or, more commonly, may involve negligence on his part. Therefore, in the normal situation (assuming the employer is not within the scope of the Workmen's Compensation Act or a similar statute), the employee's action against his employer will be founded on negligence. As such, it is necessary for him to make out a case of negligence on the part of the employer.

Briefly, the requirements for establishing a case of negligence are these: (1) the defendant owed a duty of reasonable care, (2) the defendant failed to live up to the standard of reasonable care required of him, (3) as a result, the plaintiff was injured, and (4) the defendant's lack of care was the "proximate cause" of plaintiff's injury (not merely a remote or indirect factor). In master-servant cases, the common law fixes the duty of care on the employer. He owes his employees a reasonably safe place to work, and he must exercise reasonable care to furnish them with safe tools and appliances with which to do their work. He is under a duty to see that machinery and appliances furnished for the use of employees, as well as the places where the employees are required to work, are maintained in a reasonably safe condition. If the work is of a dangerous nature and the employees because of youth, ignorance, or inexperience fail to appreciate the danger, the employer is under a duty to give proper instructions and warnings.

### Inadequate Warning

A recent case involving the requirement of instructions and warnings is *Judis v. Borg-Warner Corp. (Norge Division)*, 63 N.W. (2d) 647, a Michigan case decided April 5, 1954. The plaintiff, Judis, was a farmer who was in relatively poor health and whose adult son, Tony Judis, helped support him. Tony Judis was an employee of Green, an independent contractor who took the job of repairing and cleaning the Norge plant, including cleaning out a boiler stack. The dust that arose during cleaning made it impractical for the person doing the cleaning to enter the stack. The accumulated ashes were first partly removed by a short-handled shovel, but to reach the remaining ashes further back inside the stack, it was necessary to use a 12 foot hoe. Opposite the door in the stack was a brick wall 4½ ft away and 8 ft high; in top of this wall was a picket fence 6 ft high, the pickets being spaced 2 inches apart. Three transformers on the other side of the wall were invisible to Tony Judis when he went to work removing the ashes. There was no warning sign of danger. And, as you may have guessed, Tony Judis was electrocuted when he was lifting the hoe over his shoulder to remove it from the stack, and it came in contact with some part of the transformer.

Because the Norge Co. provided the tools and undertook to direct Green's employees as to what to do and how to do it, they were held to be Tony Judis' employer. And because they failed to give him proper warning of danger, they were held to be guilty of negligence. Result: a $5000 judgment against the company, in favor of Judis.

This case teaches a number of things. It teaches us first of all that even the employee of an inde-

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**New, modern Copyflex Model 500 gives you *all* the advantages of Copyflex diazo type whiteprinting, provides equal or greater capacity than much higher-priced machines, offers new and better operating features to help you turn out more work at less cost.**

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Large front tray takes prints up to 24 x 42 inches. Large rear tray takes sizes up to 30 x 42 inches. Extra roomy tracing tray further speeds operator's work. Movable magnetic stops in rear tray provide efficient variable stacking. A special tracing stacker, a variable front print stacker, and a print roll-up attachment are available as optional equipment at extra cost.

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A new, patented air-jet type separator device provides automatic positive separation of tracings from exposed sheets, speeds operator's work.

### *NEW* . . . 40 f.p.m. Mechanical Speed!

With a mechanical speed of 40 linear feet per minute, Copyflex Model 500 gives you fast, heavy volume production. Its 4,000-watt quartz lamp and synchronized exposure and developer units assure uniformly sharp, clear prints.

### *NEW* . . . Trouble-free, Selenium Rectifier Drive Controls!

The electrical control system of the Model 500 is free from vacuum tubes, a common source of trouble in most other machines. Use of such devices as variable transformers and 100,000-hour-life rated selenium rectifiers assure efficient, trouble-free operation.

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**All of the famous Copyflex advantages, plus new modern features, are yours in the amazing lower-priced Copyflex Model 500. Take this opportunity to trade in that old machine. Mail coupon today. You owe it to yourself and to your company!**

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Special tracing stacking device (optional) provides efficient stacking of various size originals, up to 12".

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pendent contractor may be treated as an employee of the "owner" if the owner undertakes to direct the work. Secondly, it teaches us that an employer must give his employee reasonable notice of dangers inherent in the work. Finally, it teaches us that a human life is worth about $5000.

Cases like the one above are relatively unusual for a number of reasons. In most cases, the Workmen's Compensation Act is involved although it was not here. Secondly, when the employee sets out to win a negligence case against the employer, he generally loses, either because he cannot prove negligence or because the employer has a defense.

The principal defenses available to the employer (in the absence of Workmen's Compensation) are: (1) contributory negligence on the part of the employee, (2) assumption of the risk by the employee, and (3) the "fellow-servant" rule.

Contributory negligence means that the employee has himself been careless and this has contributed to his injury; in such cases, the negligence of the employer is "wiped out," so to speak. According to the doctrine of "assumption of risk," the employee in taking the job assumes the "ordinary" risks of the job and is therefore not in a position to complain if these risks materialize into an injury. (The doctrine is similar to the rule that a boxer cannot sue his opponent for assault and battery because he has consented to such attacks within certain bounds.) According to the "fellow-servant" rule, an employer is not liable to one employee for injuries caused by the negligence of another employee.

A recent case in which these defenses were successfully offered by an employer to an action of negligence by his employee was *Paducah Battery Co. v. Edgar*, 265 S.W. (2d) 455, a Kentucky case decided Feb. 26, 1954. The plaintiff, Dorothy Edgar, worked for the Paducah Battery Co. in the

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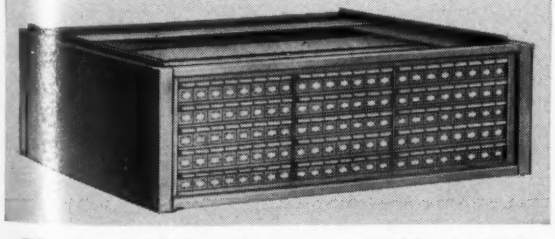

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"Buffalo"

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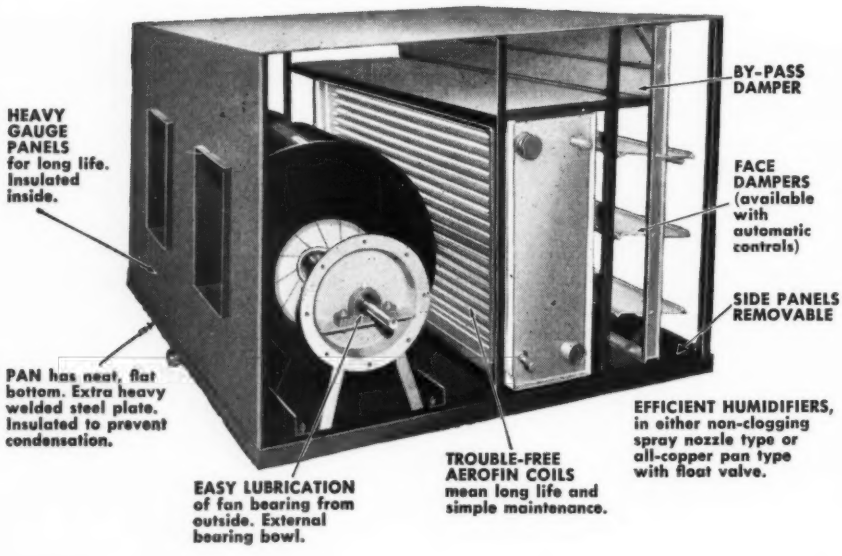
HEAVY GAUGE PANELS for long life. Insulated inside.
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PAN has neat, flat bottom. Extra heavy welded steel plate. Insulated to prevent condensation.
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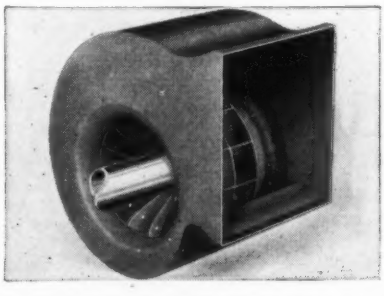
EASY LUBRICATION of fan bearing from outside. External bearing bowl.

The above view of a "Buffalo" PC Cabinet (with side panels removed) shows why these units give *lasting satisfaction on the job.* It's part of what we call the "Buffalo" "Q" Factor*. From filter box to outlet, construction is both heavy-duty and convenient for maintenance. You'll like their ease of installation, too — this horizontal PC Cabinet can be placed directly on the floor or suspended. And where space is short, use "Buffalo" VPC Cabinets. These vertical models are in three demountable sections for moving in thru standard building openings. All models available with air washer sections, too, if desired. Capacities from 875 to 22,000 cfm. *Bulletin 3703A* gives full details. Write for your copy!

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*



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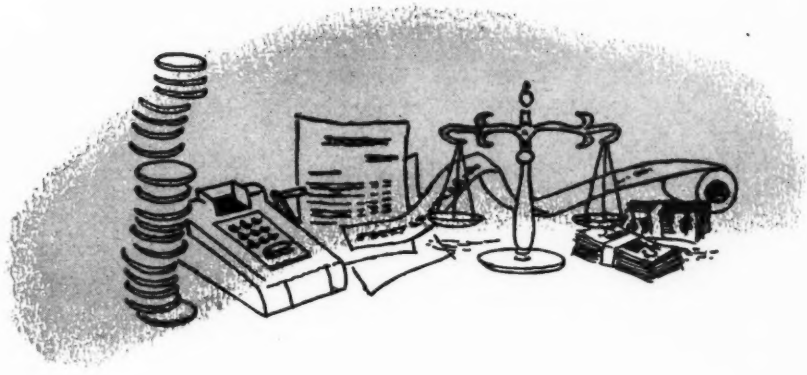
manufacture of dry cell batteries. After about two years she developed a skin irritation which was attributed by her doctor to the use of certain chemicals in the plant. After taking a leave of absence of eight weeks, her dermatitis was cured, and she returned to work, only to have a recurrence. She sued the employer for negligently providing her with an unsafe place of work. The court held that, "If anyone was negligent in this case, it was the plaintiff who continued to work after indications of her skin condition had appeared and who returned to work after this condition had been arrested." In essence, the court said that "assumption of risk" and "contributory negligence" would bar her right to collect.

Although the employee usually loses in cases not involving Workmen's Compensation, he doesn't always lose. In *Arnold v. United Gypsum* 267 Pac (2d) 689, a State of Washington case decided March 12, 1954, Arnold was employed as a representative of the United States Gypsum Co.'s Western sales division. His duties brought him to the Seattle office at about two-month intervals. One day while in the office and discussing business, he sat down on a chair next to a desk. After dialing a number on the telephone, he leaned back in the chair in the normal manner. It tipped over backwards and he was injured. According to fellow employees in the office, the chair was known to the office force to be unsafe, as several persons had nearly tipped over in it.

Arnold brought suit for negligence against the company, claiming they had failed to provide a safe place to work and safe appliances. The defense was "assumption of risk." The jury gave a verdict for Arnold, and it was upheld in the Supreme Court of Washington, the court merely saying that Arnold "was entitled to assume, in the absence of notice to the contrary, that the chair was safe for normal use." ▲▲

# ECONOMIC NEWS NOTES

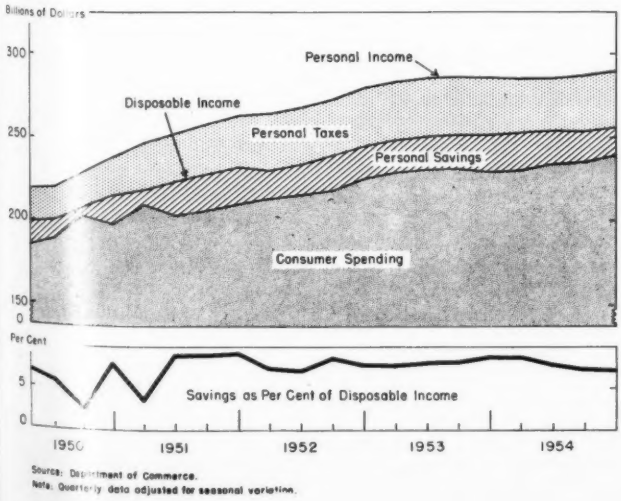


*E. F. Mac Donald*
INDUSTRIAL ECONOMIST

BULLISH — "We are going to have the biggest residential building year ever if they don't tighten up on credit and we don't get in a shooting war."—Mr. I. J. Harvey, pres. of Flintkote Co. "It appears that the fast pace of construction will continue for some years beyond 1955."—Mr. L. M. Cassidy, chairman, Johns-Manville.

CONSUMER INTENTIONS — Preliminary findings were released last month of the 10th Annual Survey of Consumer Finances conducted by the Federal Reserve System in cooperation with the Survey Research Center of the University of Michigan. Probably the best survey made of consumer intentions, it is of considerable value to business and professional men who know that consumer spending is the fundamental basis for all business activity. The survey discloses that consumers plan to buy more new homes, more furniture, and more appliances than they did last year. Significantly, 9.6% of all consumers plan to buy homes this year — 50% more than the 6.6% last year. The number interested in a new home a year from now is as large as it was in each of the three preceding surveys.

CHANGING PATTERN — The boom in the residential building and auto industries has outrun the moderate gains in income after taxes. As shown on the chart, consumers have been spending an increasingly larger proportion and saving an increasingly smaller share of income. Meanwhile, consumer indebtedness and mortgage debt have been rising to record levels. Some fear has been expressed that debt repayment will sooner or later become a drag on the economy, replacing the current stimulus of easy credit.




Source: Department of Commerce.
Note: Quarterly data adjusted for seasonal variation.

BEARISH — "I believe overproduction of homes has already begun to show up in quite a few localities, and it won't be too long from today before it begins to show up in quite a few more."—Mr. H. Abraham, chairman, Ruberoid Co. "The day of reckoning in the housing market cannot be put off forever, and I shall be very surprised if it can be put off beyond this year."—Mr. G. McKinley, economist, Prudential Insurance.

CONSTRUCTION CODE — Creation by Congress of a national authority to formulate and administer construction codes for atomic energy installations has been recommended by Admiral E. W. Mills, pres. of Foster Wheeler Corp. He points out that no rules have been worked out for the "safe construction of components of nuclear plants subject to pressure, temperature, and radioactivity, establishing minimum safe material, construction, inspection, and quality control standards acceptable to all enforcement agencies and insurance companies."

EASIER SAID THAN DONE? — Economic losses amounting annually to at least $1.5 billion are directly attributable to air pollution, claims Mr. W. B. Gibson of Stanford Research Institute. At the recent First International Congress on Air Pollution, it was stated that "We are fast approaching the time when atmospheric dilution and dispersion of contaminants no longer can be done when communities lie close to (industrial) facilities." (See "What to do when your clients need Air Pollution Control," p. 38.)

$40 MILLION — Plans have been drawn for the construction of a million square foot shopping center at Hicksville, Long Island. Provision will be made for 130 air-conditioned stores, parking facilities for over 8,000 autos, and underground delivery. The plans contemplate medical and office buildings also. The center will be a major unit in a $293 million network of 10 integrated regional shopping centers promoted by Allied Stores.

THROUGH THE TRANSIT — Necessary legislation for the proposed $300 million, 100-mile conveyor belt to haul ore and coal between Lake Erie and the Ohio River, has been blocked in the Ohio Legislature for the third time . . . . It is claimed that construction is now the nation's largest industry, accounting for about one-sixth of the nation's total output this year . . . . Private construction activity in the period 1925-29 was twice as important relatively in the economy as it was in 1950-54 . . . . At least 60 municipalities are formulating plans for slum eradication and rebuilding of former run-down areas . . . . It has been charged that over 55% of the nation's machine tools are 10 years old and older and that 1¼ million obsolescent tools are in use today . . . . In the three years ending 1954, investment in new industries and industrial expansions averaged over $120 million annually in the Baltimore area.

# ATOMS IN ACTION

SEMINOLE ELECTRIC COOPERATIVE, a federation of five electric distribution cooperatives in North Central Florida, has received permission to make a study of small, central station, nuclear power plants. The idea is to find out whether 10,000 kw atomic power plants can produce electricity at costs below those current in Florida. E. P. McLean Engineering Company and Fairbanks Morse Company are associated with this project.

PRESIDENT H. R. SEARING, of Consolidated Edison Co. of New York, says that his company will apply for a license to build and operate a reactor of about 100,000 to 200,000 kw to fit into their utility system. Searing stated that they plan to go about purchasing the reactor in the same way they would go about the purchase of any other power plant addition. He said they would order a finished product from one of their usual suppliers "if possible at a firm price." It now seems as though Babcock & Wilcox will get the job. Vitro Corp. of America are consultants and are assisting in evaluation proposals. The reactor Con Edison has in mind represents an advance in design over any of the five proto-types described in AEC releases.

WALKER L. CISLER, Detroit Edison's president, says that 60 percent of all the light and power companies in this country are now participating to some degree in projects involving nuclear development. He was referring principally to the Atomic Power Development Associates (a group of 33 companies including 25 electric power systems as well as several manufacturing and engineering firms) which is planning actual construction of a developmental reactor at an early date.

A SCHOOL OF Nuclear Science and Engineering has been founded by AEC in cooperation with the State Department and the Foreign Operations Administration. It is located at Argonne National Laboratory near Chicago and is operated for the Commission by the University of Chicago. There are now 31 scientists and engineers from 19 nations attending the new school. Several foreign consultants are enrolled, but all students from the U.S. are from industry. Consultants missed this boat.

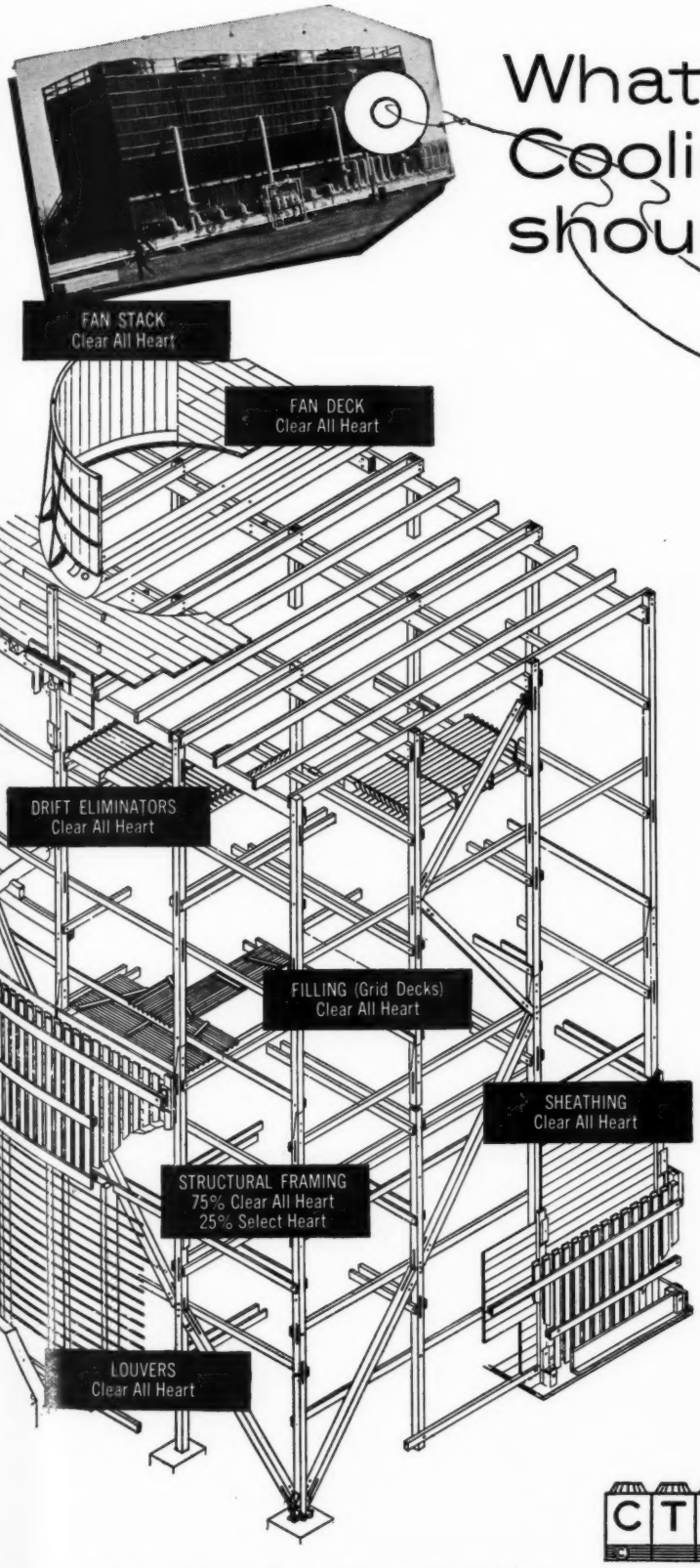
BABCOCK & WILCOX is going ahead in atomic power equipment as though they planned to make it a major part of their future business. They have purchased a plant site five miles east of Lynchburg, Va. on which they are building their Atomic Energy Division. Actual construction of main building is just under way. Here B&W will make complete nuclear steam generators for the production of electric power. The currently planned structure will cover only 100,000 sq ft with a one-story building, but the plant site incompasses 500 acres — plenty of room for expansion.

AT THE Congressional Joint Committee hearings, James G. Beckerley, a physicist with Schlumberger Wells Surveying Corporation, asked the AEC to prepare a public report, for use of scientists and engineers, describing the technical nature of non-weapons information presently held classified.

THE ATOMIC Energy Commission is now the nation's largest single electric power consumer. Sale of electric power to AEC in 1954 accounted for 4 percent of all kw hours produced in the U.S.

NUCLEAR DEVELOPMENT Associates, Inc., an engineering firm, plans to build a scientific laboratory for nuclear study near Pawling, New York. This same firm has also purchased a building and adjacent property in White Plains, New York, from Consolidated Edison.

# What every Cooling Tower buyer should know




■ A cooling tower is an important piece of industrial equipment. It can be a constant source of trouble, or a sound, profitable investment. Look at the specifications when buying a cooling tower, not at the price tag. The quality of materials from which a tower is fabricated, the structural design, the performance of mechanical equipment, its life expectancy, the experience and integrity of the manufacturer—these are the real values of a cooling tower. Be sure that the tower *size* and the *quality* of the materials meet your carefully prepared specifications.

The cost of a cooling tower is divided approximately 70% for the tower itself and 30% for mechanical equipment. Big price differences lie in the quality and sizes of lumber used in their construction. Fluor towers are prefabricated from California redwood. "Yard Grades" of California redwood are selected in this order: (1) Clear All Heart, (2) A Grade, (3) Select Heart, (4) Utility, (5) Construction Heart, (6) Sap Common, (7) No. 3 Common. Fluor uses only Clear All Heart and Select Heart in their cooling towers. A Grade contains sapwood and Fluor does not use lumber containing sapwood. The only Select Heart in a Fluor tower is about 25% in structural lumber. All the rest is Clear All Heart—the best there is.

Hundreds of thousands of board feet go into a cooling tower and prices will vary as much as $17 per thousand board feet between one grade and the next. You can readily see how substituting a lesser grade will substantially lower the price of a tower, and lower its operating life. When you buy on price, you do *not* get what you pay for.

CTI

*Fluor has been building cooling towers for 34 years and has repaired many hundreds of them—all makes and models. We know from long experience what should go into a cooling tower and what should not. Fluor towers are universally recognized as the finest you can buy. We cannot compromise with quality or offer an inferior tower to satisfy a price. We urge you to be guided by your carefully prepared specifications and not let the cost of a tower be the sole influence.*

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DENVER

# Professionalism and Unionism

**N. W. DOUGHERTY**
**Dean of Engineering**
**The University of Tennessee**

**A BITTER QUARREL arose between the horse and the stag in the days when both creatures roamed wild in the forest. The horse came to the hunter and asked him to take his side in the feud.**

**The hunter agreed, but added: "If I am to help you punish the stag, you must let me place this iron bit in your mouth and this saddle on your back."**

**The horse was agreeable to the man's conditions and he soon was bridled and saddled. The hunter sprang to the saddle, and together they soon had put the stag to flight. When they returned, the horse said to the hunter: "Now if you will get off my back and remove the bit and saddle, I will not require your help any longer."**

**"Not so fast, friend horse," replied the hunter. "I have you under bit and spur, and from now on you shall remain the slave of man."**

**Moral — Liberty is too high a price to pay for revenge.**

***Aesop***

FREEDOM IS TOO high a price to pay for economic advantage. It is too high a price to pay for group security. It is too high a price to pay for the loss of professional standing.

Now, the word "professional" may have many meanings, but we wish to confine it here to such callings as medicine, law, ministry, teaching, and engineering. These, and some other "professions," have certain things in common—such as the sharing of a specialized body of knowledge and skill, a service motive, a relation of confidence with those served, an accepted code of ethics or conduct, and a group consciousness. Professional activity requires the exercise of discretion and judgment rather than the repetition of standard routines. It is a mental activity rather than a manual skill, though a manual skill may be very desirable (as in surgery and dentistry). No one, however, would pretend that the skill is more important than the judgment exercised in controlling the skill.

Professional men group together for the sharing of knowledge and skills more than for economic gain or the improvement of their own working conditions. (However, improved economic position may come as a byproduct. It may result from better understanding that the group fosters in the general public, from fixing minimum fees, or from the study and publication of salary classifications.)

Individual responsibility, a service motive, and a relation of confidence are certainly distinguishing characteristics of the professions. In engineering, these apply to any situation where technical knowledge or skill is used. Laymen must depend upon the integrity of the engineer for correct application of his knowledge and skill.

Professionals cannot avoid responsibility for their acts, since they act as individuals and not as groups. This type of responsibility is peculiar to professionals, since only others in the same profession can determine the quality of their work. This places them in a relation of confidence to the user of their products, the employer of their services, and the public that must depend upon the care and responsibility with which they protect the public health and public safety.

Certainly one of the characteristics of a professional engineer must be independent judgment. This applies to employees, to supervisors, and to managers. In engineering, individual judgment may be somewhat obscured because of the wide variety of

responsibilities that extend across the board from beginning designer to chief engineer, from neophite worker in the research laboratory to the chief scientist or engineer, or from the instrument man in the field party to the responsible principal in the firm.

### Professional Freedom

So important is the exercise of individual judgment that an engineer dare not be the captive of any group. The relation of confidence may be with an individual, with the public at large, or with his employing company. This means that his judgment must be made without bias, without selfish hope for gain, and without prejudice for anyone.

Engineers must not be captives of labor. Ability to perform with knowledge and skill should determine the task that each individual shall perform—rather than seniority or any form of favoritism. Engineers cannot be involved in jurisdictional disputes, slowdowns, or featherbedding. They should not use knowledge gained in confidence for their own personal advantage.

Can the professional engineer line up with a union and not be a captive? The following quotation gives a picture of the union point of view: "When industrialists refuse to recognize labor's just demands, union leaders are faced with employing the only effective economic weapon they have left to use in defense of their rights, and that is strike. Strikes are to be avoided wherever possible without sacrificing the real rights of the workers." (Lee Bollens, *White Collar or Noose?)*

This picture suggests that the individual must give up his right to talk with his employer and give it to a union. The inference is that the boss will respond only to group action, and that the most potent weapon is the strike. It forgets that the white collar employee may have as much importance to top management as others in supervision. Even a beginning professional engineer should not submit to arbitrary action by any one. He has a right to expect that he will be treated as an individual.

The engineer, likewise, cannot be captive of management. He must be an independent advisor. His judgments must be determined by facts rather than by a fixed policy. Another writer expresses it this way: "The engineer is at the core of our nation's industrial growth. He originates and develops the many products of our economy. Scarcely can you name a man-made thing that the people see, feel, hear, or taste but that it comes into usage through the touch of an engineer.

"Yet, the very people who derive the benefits of all these things do not fully appreciate the importance of engineering to their well-being . . . This unparalleled achievement serves to spotlight engineering progress, to epitomize how the engineer's creativeness and continuing search for better things, and better ways to make them, have resulted in an age of unprecedented technological advancement." (Paul Garrett, General Motors' *Engineering Journal,* Nov.-Dec., 1954)

As soon as he achieves any supervisory responsibility, an engineer is classified as an arm of management. Studies of the duties of engineers indicate that a large, and growing percentage are in managerial positions. A young engineer will be well advised if he holds himself free and independent in his early years of employment.

Engineers should not be captive of government. They may be members of political parties and express their choices of officials and policies. But they are not to warp their professional judgments to favor political allies. Their duty is to the public at large.

### A Solution

It would be negligent not to suggest a partial solution of the present dilemma of the beginning engineering employee. As he compares his compensation with that of many whom he directs, he is disappointed at the rewards received for his long years of preparation. Though industry may be investing in the young engineer's further education, training, and orientation, the young engineer still must pay bills, own a car, and build a home in the interim.

Early in his career, the younger engineer sees certain members of the skilled trades receive greater pay than he. It is no immediate consolation that he will have many more working years, or that his lifetime pay will be higher than a tradesmens.

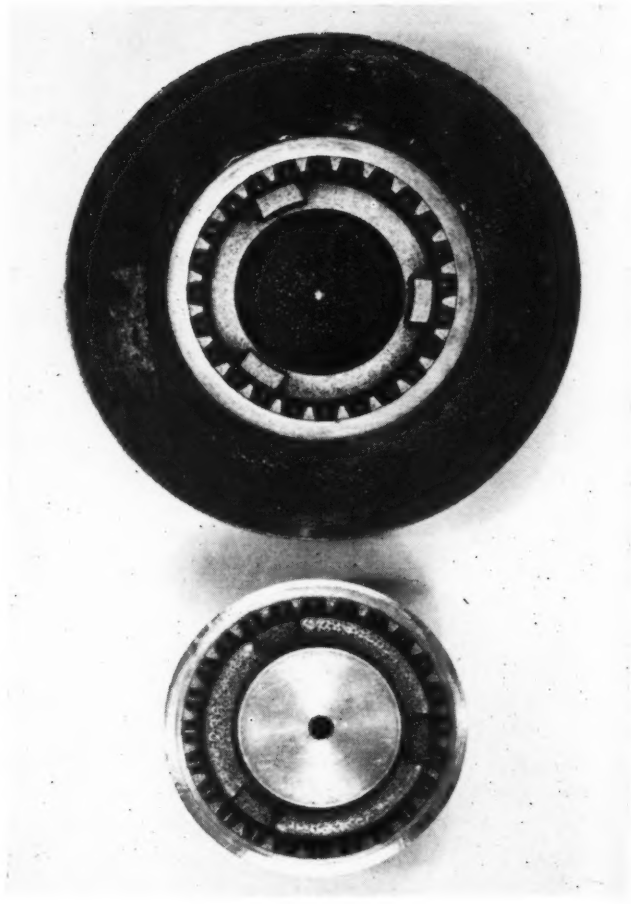
### A Principle Involved

The first few years out of college should be considered a training period rather than a life-time job. The classification of "Engineer-in-Training" in the model engineering registration law was recommended to the individual states so that beginning engineers would be earmarked as beginning professionals. They were to be so considered under the law.

The answer must lie in this principle: The engineering employer must consider himself the advocate of his engineering employees. This statement should be placed in the code of ethics of all engineers, and it must be put into practice by all supervisors of engineering employees. It will be much better for engineering management to have engineering employees looking to them for better wages and working conditions than to have them allied with bargaining groups who think of themselves as "fighting unions."

A person or an industry can buy a man's time, a part of his ability, some of his muscular energy. It cannot buy his loyalty, his good will, his affections, or his devotion. These must be earned by fair treatment, a sympathetic attitude, and a sense of belonging. Since managers and professionals are both employees in industry, it is high time that they understood each other as they are. ▲▲

FIG. 1 — TOP. CASTING DIE FORMED IN A SINGLE PIECE OF SINTERED CARBIDE BY ELECTRIC SPARK MACHINING. BOTTOM. BRASS TOOL ELECTRODE USED IN FORMING DIE. HOLE IN CENTER CARRIES DIELECTRIC FLUSHING FLUID.



# Electric Spark Machining

**EVERARD M. WILLIAMS**
**Carnegie Institute of Technology**
**and**
**C. PAUL PORTERFIELD**
**The Method X Company**

CE exclusive

ELECTRIC SPARK machining is a promising metal-working technique for the best of reasons—it performs many operations more cheaply than other available means, and it performs many operations economically impossible by other means. So-called "unmachinable" materials (such as sintered carbides and many high-temperature alloys) and difficult-to-machine materials (such as high-speed steels and titanium alloys) are machined without difficulty using electric-spark processes.

Fig. 1 shows a casting die produced in a single piece of sintered tungsten carbide. This is an operation considered impossible by other means. Fig. 2 shows an extrusion-type shape in a similar material. This workpiece is particularly striking because it was produced in a single machining operation.

Machining action produced by the passage of electricity between a tool electrode and a workpiece has been in use for about 10 years. There are three distinct processes in the field of "electrical" machining. First, there is a "sparkover" or "spark" machining, in which short arc pulses of electricity follow an ionized path between a tool and a workpiece. The path is produced in a liquid dielectric by voltage breakdown of the dielectric.

The second process is contact-initiated machining. The machining arc discharge follows withdrawal of a tool electrode that was initially in contact with the workpiece. Finally, there is electrolytic machining, in which current flows more or less continuously through an electrolyte between tool and workpiece.

Equipment of each type is commercially available in the United States, but the first of these processes is the most versatile and will probably assume the more important role. Although slow in action by soft metal standards, all electric spark machine tools are completely automatic. Once they are set up, they run for hours without attention.

In a typical process, a tool electrode is made that conforms to the shape of the part to be produced. Thus, the tool electrode in Fig. 1 appears to have a shape that is the inverse of the die to be machined. The tool is smaller than the piece to be produced by an amount that allows for the length of the spark-over gap plus the depth to which material will be removed beyond the initial spark gap. This varies with electrical conditions but is of the order of a few thousandths of an inch. Tool electrodes are commonly of brass. Extensive research has failed to turn up a better material. However, such materials as cast iron and tungsten are used for tool electrodes for certain special purposes.

The workpiece is mounted in the dielectric container, and the electrode is positioned suitably with respect to it. For the workpiece shown in Fig. 1, the tool electrode would be advanced along its own axis toward the center of the workpiece face. Fig. 3 shows the arrangement of this particular electrode

and workpiece in the work tank prior to advancing the electrode. The tank is then filled with dielectric and the electrode is advanced toward the workpiece until sparkover occurs.

The first sparkover removes a small portion of workpiece (anode) and tool electrode (cathode) at the ends of the discharge. Subsequent sparkovers take place at other points, and the electrode and workpiece gradually wear away. An automatic feed advances the electrode as needed. Forced feed of the dielectric fluid is commonly used to flush the removed particles out of the gap. In the machining of the die in Fig. 1, several tool electrodes are required to complete the operation since the tool electrode gradually loses its profile. The volume of tool eroded generally, but not always, exceeds the work volume removed. In simple operations where a workpiece is completely pierced (as in Fig. 2), only a single electrode may be required.

### Power Supply Systems

The electrical power supply for the discharge process can take one of several forms. The simplest supply system is the "relaxation" system. A capacitor, C, (Fig. 4) is charged by a d-c source through a resistor, R. As the electrode advances toward the workpiece, a gap length is reached between them at which the gap ionizes as a result of voltage stresses. The dielectric breaks down, and the capacitor discharges. Discharge currents having peaks in excess of 10,000 amperes for durations up to 100 microseconds are typical.

Following the discharge, the gap deionizes and the capacitor is recharged by the d-c source. The ohmic value of the resistor, R, is made low to facilitate rapid charging, but a minimum value of R exists below which gap deionization is impossible or unstable. Continuous discharges would then occur, with thermal destruction of the electrode and workpiece surfaces.

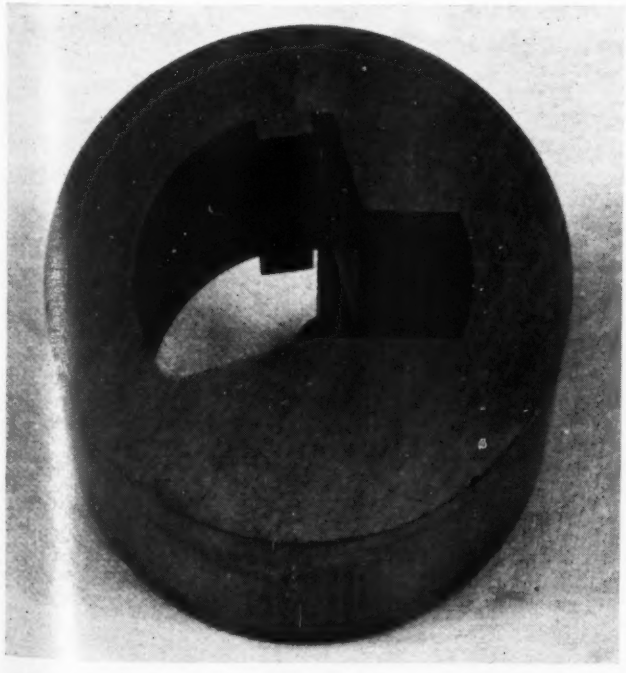


FIG. 2 — SINTERED CARBIDE EXTRUSION-TYPE DIE FORMED BY A SINGLE SPARK-MACHINING OPERATION.

FIG. 3 — WORK TANK OF ELECTRIC SPARK MACHINE IN WHICH THE DIE SHOWN IN FIG. 1 WAS FORMED.

Some of the other systems have some advantages over the relaxation system but the accuracy, surface finish, and machining dimension repeatability of these other systems are poor. The so-called "independently timed" systems however are preferable for the fastest and most accurate work. These systems use more accurately determined pre-sparkover voltage, discharge current, and discharge duration. The relaxation systems are inexpensive and easily assembled. The major cost of this simplest form of spark machine is in the associated mechanical positioning and feeding parts.

Since there is substantially no force on the tool electrode, a great variety of electrode forms can be used for the production of unusual holes and surfaces. Curved electrodes are used to generate curved holes and curved surfaces. Interior holes can be formed that are larger than the entrance hole. However, considerable care is necessary before precise work and good surfaces can be obtained.

### Theory of Electric Spark Machining

The nature of the phenomenon by which material is removed from the workpiece has been the subject of considerable controversy. It now seems clear that the principal agent in material removal is an electric field force acting on the metal ions. This

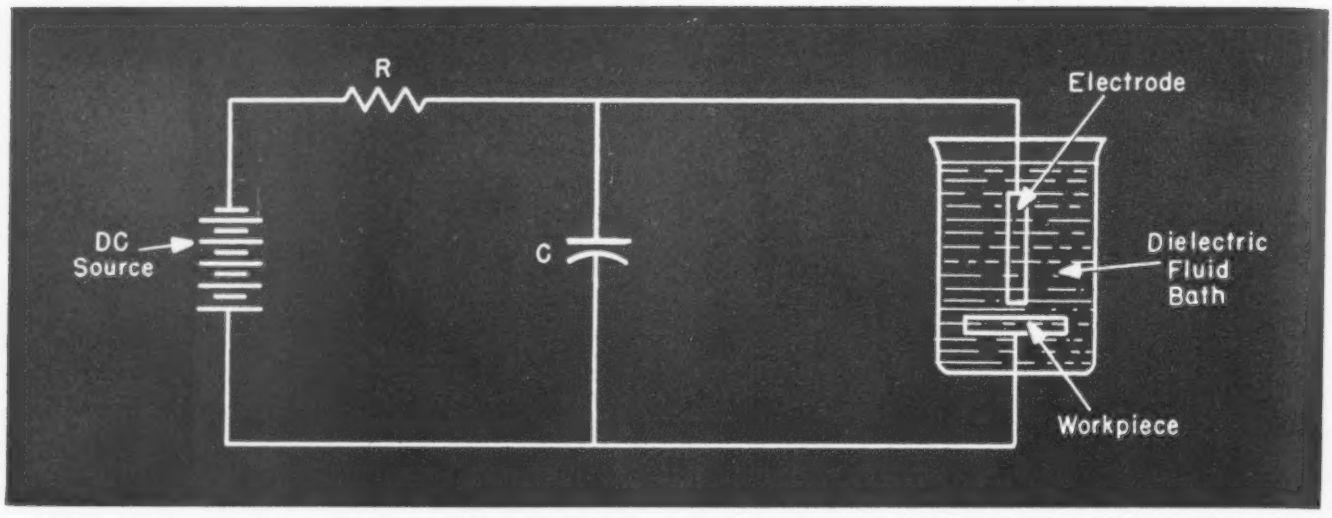



FIG. 4 — THIS DRAWING SHOWS THE LAZARENKO OR RELAXATION CIRCUIT FOR USE IN ELECTRIC SPARK MACHINING.

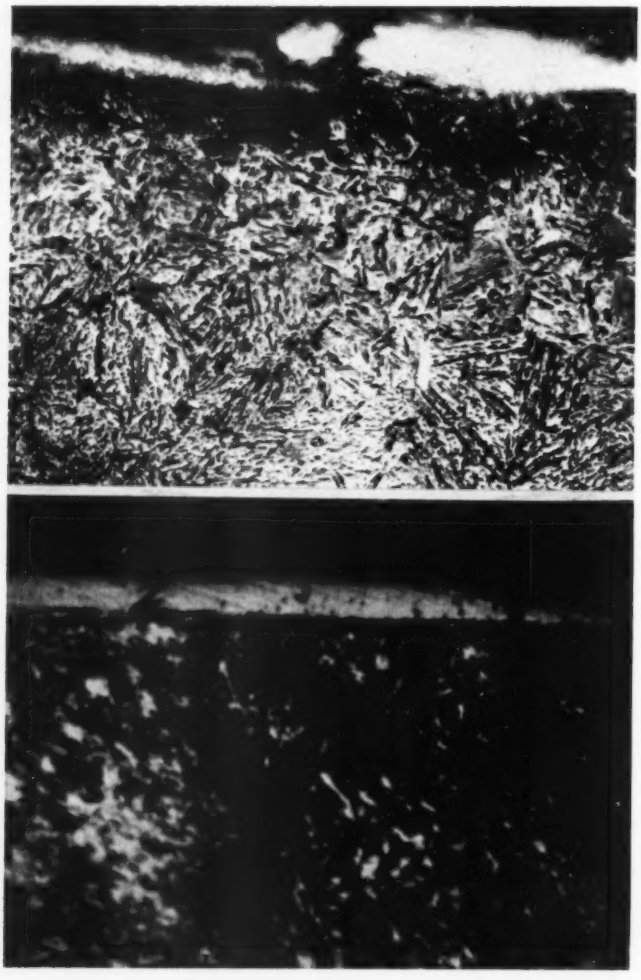


FIG. 5 — TOP. PHOTOMICROGRAPH OF SECTION Through electric-spark-machined surface in hard steel. Semiattached white layer near top is surface deposit phase. Black layer below surface is decarburized phase. Remainder of piece is unmodified. Bottom. Photomicrograph of section through piece of high-speed steel. White layer on top is surface deposit. Intermediate modified zone does not exist in this specimen. Magnification in these two specimens is approximately 500X and each of the layers shown in these sectional views is approximately 0.0005 inches thick.

force removes material wherever the current distribution in the workpiece (anode) surface is such that this mechanical force exceeds the ultimate tensile strength of the workpiece material.

The transient temperature rise at the electrodes due to a single discharge should not exceed about 600 C. The duration of this temperature is so short that significant structural changes should not result from this cause alone. Unfortunately, the removed material is drawn into the discharge path (where temperatures exceed 5000 C) and is vaporized. Often this material is then blown by high-pressure hydrocarbon vapor back against the workpiece surface and condenses to form a superficial surface layer there. The heat of layer condensation often causes structural changes below the workpiece surface, but rarely to a depth over 0.0015 in.

The machined object thus may actually have three zones (Fig. 5)—a primary unmodified zone including the main workpiece body; a second zone continuous with the first in which temperature transformation or decarburization (depending on the nature of the material) has occurred; and a third zone of superficially connected surface material consisting of condensed metal vapors.

The second zone can be reduced or eliminated by care in machining to insure adequate flushing of accumulated particles, cooling of the workpiece to carry away the accumulated heat of successive discharges, and similar measures. It may not detract from the usefulness of the machined surfaces anyway. The third zone sometimes can be easily removed; in fact, it is automatically removed by use when the workpiece is employed as a tool. On some shapes either or both of the outer zones can be removed mechanically by grinding or lapping.

The role of the dielectric fluid is a multiple one. First, it permits sparkover at much lower voltages and at much closer spacings than is possible in air or other gases at atmospheric pressure. Second,

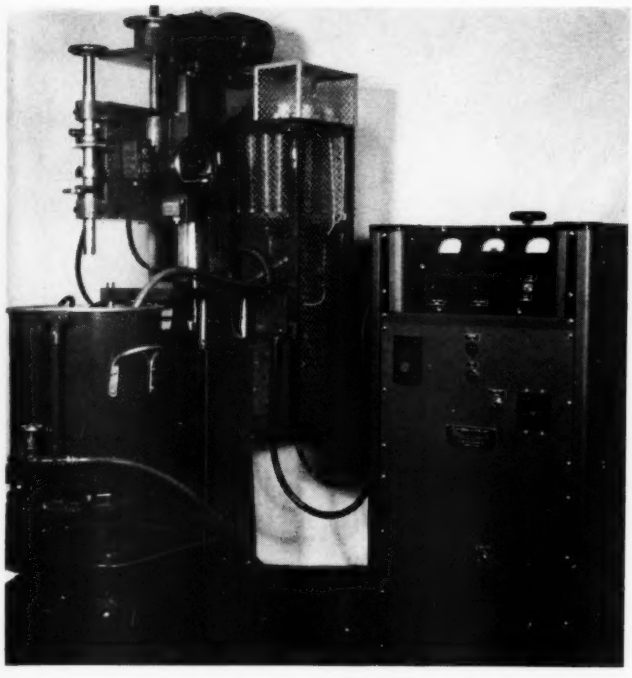


FIG. 6 — PHOTO SHOWS AN ELECTRIC SPARK MACHINE TOOL CONSTRUCTED FROM MODIFIED DRILL PRESS.

as soon as sparkover takes place, the atoms of the dielectric fluid provide a dense source of positive ions that neutralize electron space charge and permit the high current density that is essential for the development of the mechanical forces. Next, the dissociation of the dielectric into hydrogen and other components accelerates deionization of the discharge path. Fourth, heat transfer to the relatively cool liquid minimizes undesirable thermal effects. Finally, the liquid acts as a vehicle to support and carry away the machined particles.

Kerosene is commonly used as a dielectric although a wide variety of fluids—transformer oil, mineral oil, water, and many others—have been reported as preferable in some instances. The use of kerosene in enclosed work tanks, for instance, often leads to explosions caused by electrical ignition of vapors.

### Machining Speeds

It is evident that as speed is increased, the quality of the surfaces may more readily deteriorate because of the formation of deeper surface zones. There are other, absolute limits to machining speed in any particular operation. Some limitations are caused by the inability of the dielectric to recover from individual discharges when the sparkover repetition rate exceeds a workable value. Other limitations are brought about by accumulations of machined particles in such a manner as to clog the machining gap.

Current units (Fig. 6) have maximum material removal rates approaching 0.1 cubic inches per minute in small machining operations. Although this rate may appear slow, it exceeds that of diamond tools used under the same conditions, and the electric power consumed in spark machining is less. When machining takes place over large surfaces, machining speed is limited only by the power capability of the apparatus. No limits can be cited because this area is relatively unexplored.

At present, spark machining can perform operations (Fig. 7) that have been considered impossible with other present-day materials and methods. The basic techniques and apparatus are simple in principle, but require skill and a thorough understanding of the physical phenomena involved for successful application—especially when the highest speeds are desired. As new machines are developed that make automatic decisions now requiring skill, the process will become more easily applicable in all of the major metalworking industries. ▲▲

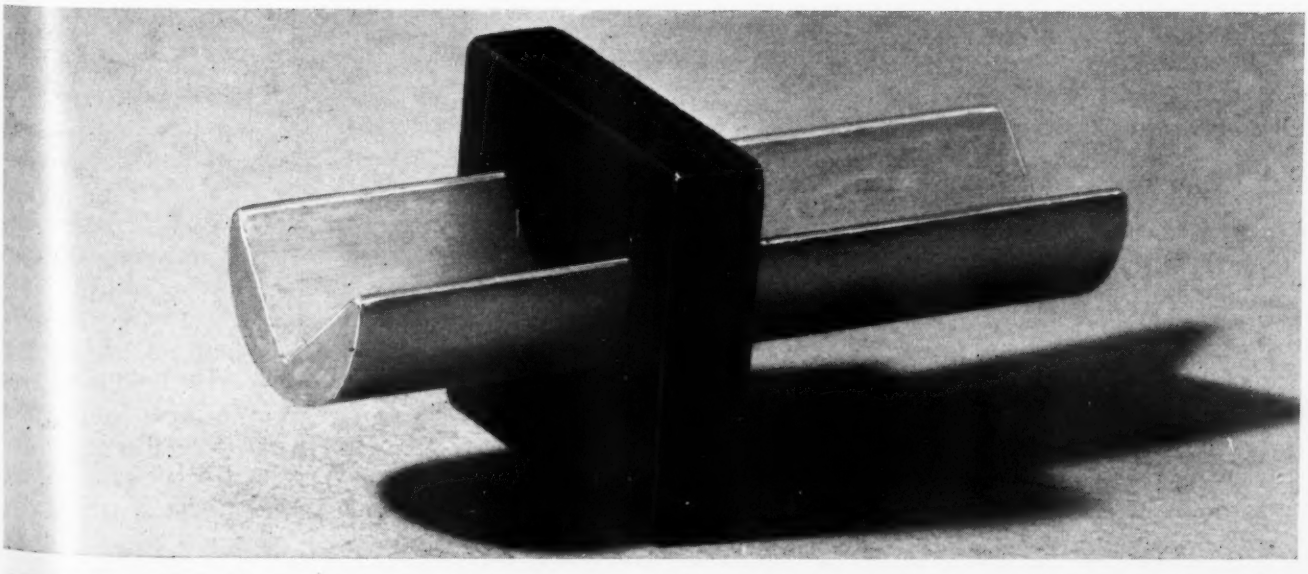


FIG. 7 — INTRICATE SHAPE WITH THE TOOL INSERTED ILLUSTRATES THE ACCURACY OF ELECTRIC SPARK MACHINING.

## What to do when your clients need

# Air Pollution Control

CE exclusive

WILLIAM G. CHRISTY, Consulting Engineer

THE CONSULTING ENGINEER has a most important function in controlling air pollution. It is most unfortunate that many small enterprises, and sometimes larger ones fail to retain consulting engineers when building a new plant or revamping an existing one. If competent consultants were always retained for those projects, there would be a marked improvement in the cleanliness of our urban and industrial area atmospheres.

Furnace designs that prevent or at least reduce air pollution should be the goal of all engineers. This should be true even if there are no ordinances or regulations covering air pollution in the area. Correct design is the starting point in any program to improve the air we breathe.

Whenever there is emission of smoke, soot, cinders, or fly ash, proper combustion should be given first consideration. This involves many factors, but the requirements for good combustion may be expressed briefly as "TTTU." These represent Temperature, Turbulence, Time, and Uniformity. The Temperature must be well above the ignition point of any component of the fuel. Turbulence is needed to insure a thorough mixture of combustible and oxygen. There must be Time for the reaction to be completed—hence an adequate furnace volume. The other requisite is Uniformity of fuel and air supply. These four requisites are obtained in various ways, depending on the fuel, the service, the load characteristics, and often other variables. Good design, taking these factors into consideration, is the responsibility of the consulting engineer.

The program of any political subdivision to eliminate air pollution must provide for the control of

equipment. The ordinance, local law, or by-law must contain a provision requiring the filing of plans, specifications, and permit applications. This provision generally includes any construction, reconstruction, installation, alteration or repair of any equipment capable of producing air pollution. The application is examined by an engineer of the control bureau. If approved, a work permit is issued. When work is completed, it is inspected by the bureau and, if approved, an operating certificate issued. The control bureau usually has regulations covering specifications for various items. Such a program is essentially a long range one. Over a period of years, old and obsolescent equipment is gradually replaced with modern and well designed apparatus.

If there is no control of equipment by the control bureau, experience has shown that installations that will emit air pollution from the day they are put in operation will be made by sub-professional engineers. Intense competition and the eagerness to get jobs often result in contractors cutting bids and then cutting corners. It is too much to expect of human nature that everyone will operate conscientiously without policing.

### Design and Selection

But even strict control of equipment is not enough. The best regulations cannot very well take care of future requirements and changes. Consulting engineers in charge of boiler projects ought to make provisions in boiler design for future changes in fuel. During World War II many plants were required by Government regulations to change from fuel oil to solid fuel. Many of these plants were designed for oil only and had no facilities for handling coal and ash. A lot of them could not readily provide enough furnace volume for high volatile coal. Dust collectors were not available. As a consequence, plants that had been proud of clear stacks started emitting smoke, soot, and fly ash. Provision for burning two or three fuels makes good economic sense in most parts of the country anyway—even forgetting air pollution.

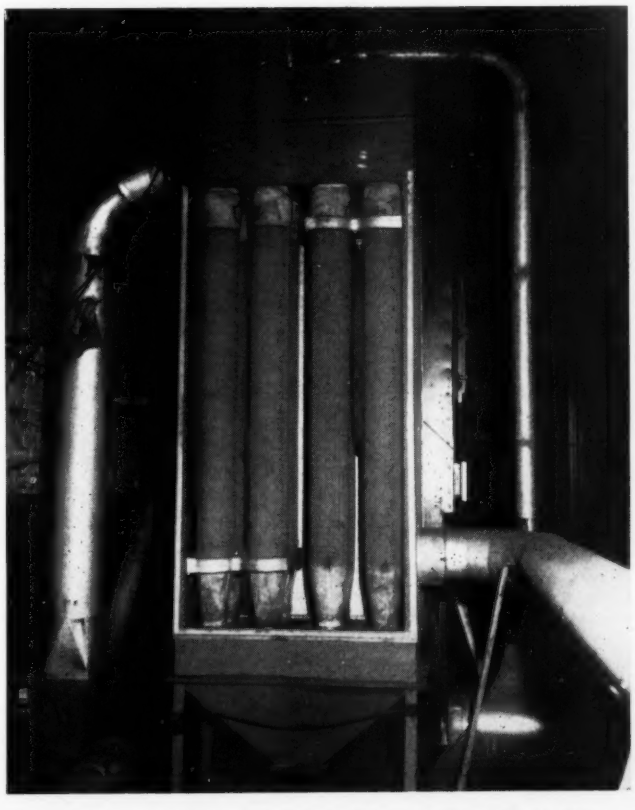
Selection of equipment is always important, not only for elimination of air pollution, but also for economy and for satisfactory performance. For a new boiler plant, it is poor practice to select equipment with capacities greatly in excess of anticipated load requirements. Instead, space should be provided for later addition of more boilers, dust collectors, and auxiliary equipment. Instrumentation is an item frequently overlooked or not given the attention it deserves. Both indicating and recording instruments are excellent aids to the operator and the supervisor. Combustion control is helpful in maintaining good smoke performance. Automatic combustion control is better than manual control and is usually more economical.

The consulting engineer can often help very materially in eliminating or substantially reducing air pollution emanating from an existing operation. There is no formula or standard procedure. An investigation, study, and analysis is needed for each job. In most instances something can be done even if only a temporary expedient for partial control until complete revamping is possible.

### Equipment Capacity

Capacity of equipment in far too many instances is not given enough attention. This applies particularly to smaller industrial and commercial steam plants and heating plants. Most air pollution control directors have hundreds of trouble cases brought about by overloading of equipment. Most small enterprises grow. This may mean adding new machines, new services, new processes, and more employees. There then is increased demands for steam, hot water, heat, power, and refrigeration, without provision for additional capacity in steam generation, fuel burning, dust collecting, or fume disposing equipment. Attempting to force such equipment beyond its capacity creates excessive air pollution.

In many communities, a goodly share of the air pollution comes from heating plants, including domestic units. Many of them receive little care or maintenance. In the past, a great many heating boilers and furnaces, especially the smaller ones, were undersized. This condition has improved to some extent. Excellent work has been done by the



THIS TUBULAR DUST COLLECTOR WAS TESTED ALONG WITH OTHER MODELS BEFORE A CHOICE WAS MADE.

Steel Heating Boiler Institute, the Institute of Boiler & Radiator Manufacturers, and the Warm Air Heating Association, in establishing rating codes. But there are still far too many homes and small buildings with inadequate equipment. Every community should have a heating code. Most areas have building, electrical, and plumbing codes. If we had heating codes, smoke inspectors would have fewer headaches from overloaded heating plants.

### Dust Collectors

This question of capacity also applies to dust collectors, in large plants as well as small ones. Dust collectors are designed and sized according to the gas volume coming from the fuel burning equipment. If the rate of fuel burning increases for any reason, the gas volume is increased. If this has not been anticipated, the collector is overloaded. In many instances the gas volume is calculated on the basis of 14 percent $CO_2$. Then the unit is operated at 8 to 10 percent $CO_2$. This increases the gas volume considerably beyond the peak load of the design. With any type collector, increase in gas volume beyond design load results in decreased collection efficiency and increased dust emission. The collector efficiency in many older installations is considerably below guarantees. With the multitubular type collector, the draft loss from increased gas volume may be so high that it is difficult to operate the boiler at full design load.

Good operation and maintenance is just as essential for dust collectors as for other plant equipment. It would seem to be only good practice to clean out dust hoppers before they are filled. Yet, there are hoppers that fill up in two or three hours but are emptied only every eight hours. Electrostatic collectors are sometimes turned off at night when the smoke does not show. In many plants night operation and maintenance are not up to the standards of day operation. For minimizing air pollution the importance of operation and maintenance by capable personnel cannot be stressed too much. The consultant may find that the problem is not in the equipment but in the personnel.

### Fuel Selection

Selection of fuel pays a major role in control of smoke, soot, cinders, and fly ash. Fuel quality often is not given proper attention. The fuel order may be given on basis of friendship, to the glib salesman, or for the fuel having the lowest price per ton or per gallon. Most stokers require coal of certain characteristics for best results. The consultant should give recommendations to management that guide the plant or chief operating engineer in selecting fuels of the kind best suited to his equipment.

Despite the advantages and economy of mechanical firing, there is still a lot of hand fired equipment in use. If bituminous coal is used for hand firing, it ought to be coal containing less than 20 percent volatile. Small vertical boilers such as those used in portable equipment and sometimes in very small plants are so deficient in furnace volume that smoke will often result with the use of even the lowest volatile bituminous coal. Most control bureaus require the use of coke or anthracite in this type of equipment.

In the late 30's, when it was found that much of the pollution in St. Louis was coming from hand fired equipment using high volatile bituminous coal, the City passed an ordinance prohibiting its use. Hand fired fuel was required to have a volatile content of less than 23 percent. This caused a lot of controversy in the coal industry and even among engineers. But the enforcement of this law resulted in the elimination of most of the smogs. Pittsburgh, Cincinnati, and some smaller cities have adopted similar legislation. The City of Providence went even further and required hand fired boilers and furnaces to use anthracite or coke.

### Sulfur Content

Many air pollution control officials and engineers are concerned about the high sulfur content of some fuels being used. Sulfur gases, resulting from combustion, are quickly converted to sulfuric acid upon contact with oxygen and moisture in the atmosphere. Sulfuric acid is responsible for much of the damage caused by air pollution. I have seen coal analyses showing 7 percent sulfur content. Some of the oil brought in from foreign fields runs as high as 7 percent sulfur, but this oil is usually blended with lower sulfur oils. The commercial heavy fuel oils being sold in some parts of the country have sulfur content of 2½ percent or more. A survey made by the Bureau of Smoke Control, City of New York, disclosed that one company was marketing a No. 6 fuel oil running 5 percent sulfur. Los Angeles County placed a limitation on the concentration of sulfur gases in the effluent from any stack. Probably in the near future, the public will be demanding that sulfur gas emission be curtailed.

Every consulting engineer is interested in air pollution control as a citizen and as an engineer. Many civic programs are led by engineers. As a rule, the most successful pollution control programs are those that secure the cooperation of the offenders. It has been my experience that at least 80 to 85 percent of the offenders will cooperate in a constructive program. The most important element of success in this undertaking is to obtain the cooperation of all concerned.

Sterner measures may have to be taken with the comparatively small number who do not go along voluntarily. This is up to the control board. The consulting engineer, however, will be doing his clients a favor to recommend action before legal orders are issued. ▲▲

THE NEW BRUNSWICK INTERCHANGE ON THE NEW JERSEY TURNPIKE IS A GOOD EXAMPLE OF THE DOUBLE J TYPE INTERCHANGE. BOTH TURNPIKE AND CONNECTING ROAD MAKE USE OF J DESIGN. TOLL BARRIER IS IN BETWEEN.

# Designing Highway Interchanges

**ARTHUR W. KEITH**
**Chief, Highway Design**
**De Leuw, Cather & Brill**

Arthur W. Keith is an old hand at designing highway interchanges. As Chief of the Highway Section of De Leuw, Cather & Brill, he has been or currently is working on designs for sections of the New Jersey Turnpike; the Garden State Parkway, New Jersey; the Sunshine State Parkway, Florida; the Turner Turnpike, Oklahoma; the New York State Thruway; the Taconic State Parkway, New York; and the Massachusetts Turnpike. His other major projects include expressway designs for Richmond, Virginia; Milwaukee, and San Francisco. A graduate in Civil Engineering from the University of Illinois, Keith joined Charles De Leuw & Company, in 1936, and except for Army service has been with this firm continuously. He is a member of the Western Society of Engineers.

In this article, Keith gives information on interchange design that is of timely importance in view of the great highway planning now under way.

CE exclusive

INTERCHANGES are, generally speaking, the only means of getting on or off an express highway. They are usually placed from 10 to 30 miles apart, at locations where surveys show that a sufficient volume of traffic can be attracted from intersecting roads to justify the expense. In developed areas, or for expressways that pass near large cities, interchanges may be located much closer together. The New Jersey Turnpike, for example, has two interchanges placed about eight miles apart serving the city of Camden. Since interchanges of any type need about 20 acres of land, they are usually located in open country or in sparsely-built-up suburban areas.

Basically, there are two types of interchanges. The first is the cloverleaf and its modifications. These are used on free expressways or parkways where no toll is collected, or where the collection is at a barrier-type toll plaza. In a full cloverleaf, no left-hand turns are permitted even on the feeder roads. In modifications of this type, circle turns on the feeder roads may be allowed.

The second category of interchange is known as

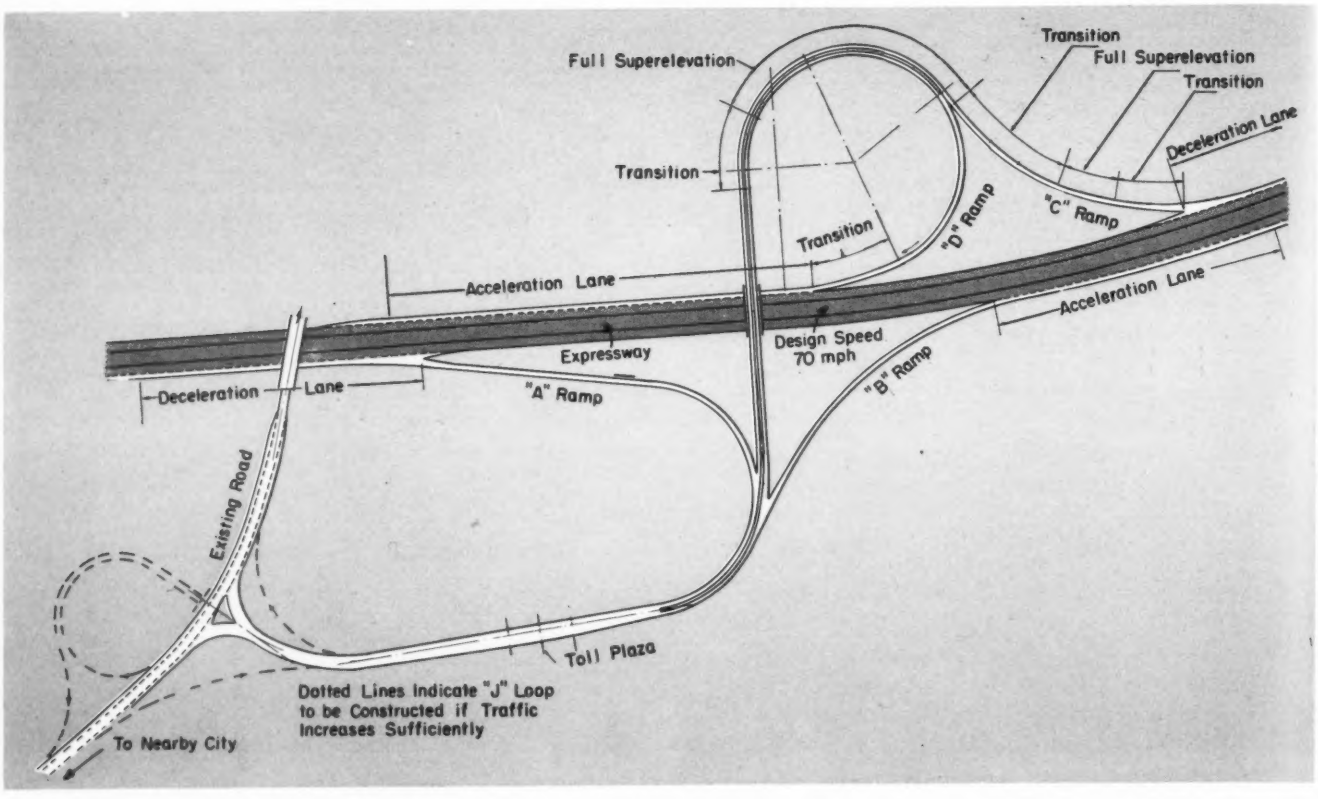



FIG. 1—A SINGLE J INTERSECTION CONNECTING AN EXISTING ROAD AND A NEW EXPRESSWAY. INTERSECTION AT EXISTING ROAD REQUIRES LEFT TURNS. DOTTED LINES INDICATE J LOOP TO BE BUILT IF TRAFFIC INCREASES.

the "J" or "Trumpet" type (Fig. 1). It is used when a toll is to be collected from all traffic using the expressway. To accomplish this economically, traffic is routed through a single toll collection plaza, usually located at one side of the expressway. This type of interchange may also be used on a free expressway, with the toll plaza omitted.

The simplest form of a Trumpet interchange consists of a "T" connection to one intersecting road whose traffic is to have access to the expressway. The toll collection plaza is located on the stem of the "T." The expressway side of this plaza is connected to both sides of the expressway, with separate ramps for traffic entering and leaving each traffic stream. The ramps to the side of the expressway farthest from the toll plaza are carried over or under the expressway. They are then connected to the expressway by curving both ramps in the same direction because this design requires less land area. This is the part of the interchange that creates the typical loop from which the name "J" or "Trumpet" is derived.

The connection to the intersecting road is always located on the side of the expressway that provides the shortest route for the heavier regular traffic flow. The length of the acceleration and deceleration portions of the ramps, the minimum radii of curves, and the maximum grades allowable will determine the over-all size of the interchange. At most interchanges, single lane ramps are adequate. But when traffic on a lane exceeds 1200 cars per hour, additional ramps or two-lane ramps should be used.

One of the basic considerations in the design of any interchange is whether left-hand turns will be permitted on the feeder roads. A simple rule-of-thumb is that when any lane in the projected interchange will carry more than 600 cars per hour, no left-hand turns should be permitted. Then, a double "J" interchange should be used. Many of the interchanges built on the New Jersey Turnpike, the Pennsylvania Turnpike, and the New York State Thruway use the double "J". While access is usually restricted to interchanges, there are some expressways in urban areas that may be reached by simple, direct ramping—such as the Franklin D. Roosevelt Drive and the West Side Highway, in New York City. At such ramps left-hand turns are permitted at connections to intersecting streets.

While left-hand turns may be permitted on simple access roads in the beginning, traffic may increase to an extent that would alter the situation. At present, for example, left-hand turns are permitted on the connection between the New York State Thruway and Route 23, the main road to the Catskills. There is now a single "J" loop there. However, traffic at this point is increasing so rapidly that the New York State Thruway Authority is acquiring property to build a second "J" loop to eliminate all left-hand turns.

Still another type of interchange is that at which

more than two roads intersect, such as at Kew Gardens, in Queens, New York City. Here, Grand Central Parkway, Van Wyck Expressway, Queens Boulevard, and Interboro Parkway all converge. There is another such complex interchange on the Harbor Freeway, in Los Angeles, which results in four levels of roads. Such interchanges are always special problems.

In densely populated urban areas where simple ramping is used, and left-hand turns are permitted on connections to existing streets, ramps should collect traffic from as few cross streets as possible. At the same time, care should be taken not to have all access by a single street but to make ramps fit in with the city's pattern of street traffic. For example, northbound traffic on the Franklin D. Roosevelt Drive (East River Drive) in New York City exits at 61st Street and enters at 62nd Street. Southbound traffic exits and enters at 63rd Street.

### Location Studies

Interchanges should be located as near as possible to areas needing access to the expressway. They should be designed so that the preponderance of traffic will have the shortest travel distance. At the same time, the future development of the area, and the effect of the interchange itself on traffic flow should be taken into consideration.

It is desirable to have as many of the preliminary location studies as possible done in the office before field reconnaissance work is begun. This prevents undesirable confusion among property owners in the area who might be led to draw false conclusions about the actual location of the interchange. The preliminary studies should be made with the aid of all available maps, aerial photos, topographic studies, and plans for projected developments in the area.

Drastic alteration in the shape of an interchange may be necessary because of a topographic situation — such as a hill, river, railroad, or airport. A factory, school, or cemetery may be located close to the proposed site and make it advisable to swing one of the loops of the interchange one way or another or to substitute a special design for the typical loop. On the New Brunswick Interchange on the New Jersey Turnpike, both a stream and an awkwardly placed existing crossroad influence the design. At the Newark interchange on the New Jersey Turnpike, an airport on one side and a railroad on the other forced special treatment.

When all such factors have been studied, field reconnaissance should be undertaken to make the necessary surveys and to prepare an accurate topographic map on which the interchange can be laid out. The information obtained by the reconnaissance party should be adequate to prepare a map of the area at 1 in. to 50 ft and at a contour interval of 1 ft.

When this map is prepared, the interchange should be drawn on it. Additional single-line profile drawings of the interchange roadways should be made so that the approach ramps can be studied for the most desirable grades and sight distances.

It is always desirable to give the approaching driver a completely unobstructed view of all possible

AIR VIEW OF HIGHTSTOWN INTERCHANGE ON THE N. J. TURNPIKE. THIS IS A CLASSIC DOUBLE J WITH TOLL BARRIER.

WHILE A MINIMUM LOOP RADIUS OF 200 FT IS DESIRABLE, THIS NEWARK AIRPORT INTERSECTION OF NEW JERSEY TURNPIKE HAS A SHARP TURN ON A SHORT RADIUS (LEFT CENTER). NOTE WIDENING OF ROADWAY REQUIRED.

ramps, and to avoid making connecting ramps that dip suddenly from the main highway. Exits that loom up suddenly in front of the driver as he emerges from under a structure also should be avoided. To accomplish this, ramps should take off ahead of any structure that might obstruct the driver's view of the road ahead.

On high-speed expressways as many of the interchanges as possible should be similar in shape. Experience on the New Jersey Turnpike and the Turner Turnpike in Oklahoma has demonstrated that such a similarity of interchanges tends to reduce driver confusion and to eliminate any slowing down of traffic. Regular users of these expressways soon become accustomed to an interchange pattern.

### Ramps and Loops

The length of the approach ramps to an interchange will be affected not only by the design vehicle speed of the expressway but by the topography of the surrounding area and the consequent shape of the interchange itself. The amount of superelevation and the compounding or spiraling of curves in the interchange also will be factors determining the length of the approach ramps. If an extremely short radius curve is necessary, it may not be possible to superelevate enough to permit cars to travel around it at normal speed. Longer acceleration or deceleration lanes then would be required.

Still another consideration is the possibility of icing that may be expected in certain regions. This will limit the amount of superelevation on ramps. Severe icing conditions would call for a decrease in the superelevation and a consequent change in the allowable speed.

The desirable minimum radius for the loops is 200 feet, since a sharper curve is uncomfortable for the driver. A larger radius adds to the cost through the need for additional land and additional construction. However, other considerations sometimes dictate use of a longer radius.

Loops of 200-foot radius are used on most interchanges such as those on the New Jersey Turnpike and the Turner Turnpike in Oklahoma. The New York State Thruway interchange loops have a radius of 300 feet to allow extra comfort for the driver. At the New Brunswick interchange on the New Jersey Turnpike, there is one interesting road loop with a radius of only 125 feet. This was necessary because of existing streets and buildings. This sharp turn necessitated widening the roadway from the standard 12 feet to about 23 feet. Loops with a 200-foot radius ordinarily would have roadways about 16 feet wide, while those with a 300-foot radius would have roadways about 14 feet wide.

Standard practice is to make the design speed of exit ramp curves about 70 percent of the design speed of the main roadway. This is not always economically possible because of topography or high property values at the site of the interchange. Then,

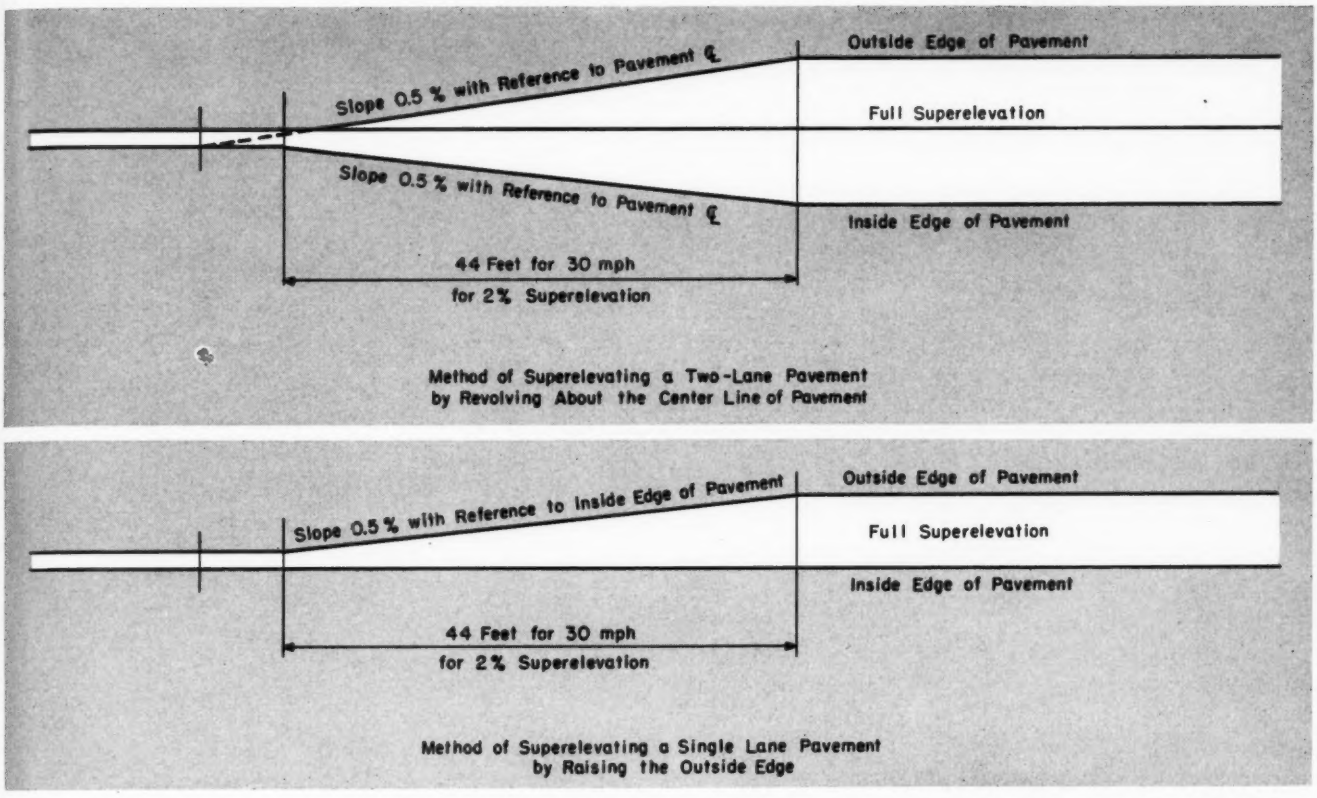

Slope 0.5 % with Reference to Pavement ℄
Outside Edge of Pavement
Full Superelevation
Slope 0.5 % with Reference to Pavement ℄
Inside Edge of Pavement
44 Feet for 30 mph
for 2% Superelevation
Method of Superelevating a Two-Lane Pavement
by Revolving About the Center Line of Pavement
Slope 0.5 % with Reference to Inside Edge of Pavement
Outside Edge of Pavement
Full Superelevation
Inside Edge of Pavement
44 Feet for 30 mph
for 2% Superelevation
Method of Superelevating a Single Lane Pavement
by Raising the Outside Edge

FIG. 2 — IN TRANSITION TO SUPERELEVATION, SLOPE OF OUTER EDGE OF PAVEMENT SHOULD NOT BE GREATER THAN 0.5 PERCENT WITH RESPECT TO CENTERLINE. SAME FACTOR HOLDS FOR INSIDE EDGE OF TWO-LANE ROAD.

more distance should be provided in the acceleration and deceleration lanes to permit traffic to reduce to the design speed of the curves.

### Superelevation Factors

In the transition to superelevation from the normal pavement level, recommended practice provides that when the edges of pavement are revolved about the center line, the slope of the outer edge, with respect to the center line, should not rise at a rate greater than 0.5 percent. The slope of the inside edge should drop at the rate of rise of the outside edge (Fig. 2).

This practice is usually employed on two-lane roadways. On single-lane roadways, the recommendation is to superelevate by raising the outside edge, while the grade of the inside edge remains unchanged. The same limiting factor of 0.5 percent governs if applied with respect to the inside edge.

On the New Jersey Turnpike, we found that a transition based on the design speed of the curves (with 2 percent superelevation being accomplished in the distance traveled per second of time) appeared to be correct. For example, on a curve with a design speed of 30 mph, a 2-percent superelevation would be reached in 44 feet. This is a .55 percent change in slope in the direction of traffic with respect to the inside edge of the pavement. This slight increase beyond the recommended maximum is satisfactory.

The total amount of superelevation is usually calculated by a standard formula which may be found in textbooks. As a rule, the authority responsible for the project furnishes its own standards for normal superelevation and for the maximum permissible superelevation. In interchanges total superelevation should not be greater than 10 percent.

While on such an interchange as the one shown in Fig. 1, which has a radius of 200 feet or less, the specified amount of superelevation for the design speed of such a curve might be 10 percent, it would be preferable to use less superelevation in actual practice. This would give the driver a more comfortable transition.

### Acceleration and Deceleration Lanes

The length of the acceleration and deceleration lanes on an expressway and its intersecting roads will vary, depending on the design speeds. For example, a deceleration lane from a 70-mph expressway to a 50-mph area should be at least 1000 feet. At least 500 feet should be allowed to decelerate from 50 mph to 35 mph. Other factors will be the grades, the sight distances, and the volume of traffic. (An upgrade deceleration lane coming off a 70-mph expressway might be shortened to about 750 feet, since the grade itself would have a braking effect.)

A deceleration lane might have to be lengthened indefinitely, for example, to take care of traffic backing up at locations where congestion on a crossroad might be expected. This would avoid backing up on the expressway proper. ▲▲

**It's available if you ask for it,**
**but neither buyers nor sellers are too enthusiastic.**

# Liability Insurance for Engineers

CLARENCE T. HUBBARD

CE exclusive

CAN A CONSULTING ENGINEER obtain liability insurance to cover any claims or suits brought against him as the result of provable faulty engineering work?

He can, under a somewhat restricted coverage, but this type of policy has very limited insurance company acceptance. Oddly enough, aside from the State of Texas, there are no regular policy forms provided for such coverage. In Texas there is an "Architects' Professional Liability Policy" which will serve as engineering liability coverage by substituting the consulting engineer in place of the architect. A handful of the Eastern, Midwestern, and Northern casualty insurance companies also provide this specialized cover, with some limitations, under a regular "Manufacturers' and Contractors' Liability Policy."

This "Manufacturers' and Contractors' Liability Policy" is a common form of liability insurance, but its terms do not automatically provide the engineer with any protection covering bodily injury or property damage resulting from provable faulty design. When such coverage is authorized, a special endorsement is prepared and attached to the policy at increased rates. Such rate charges have not been exorbitant on policies issued to date.

### On Request

Seven well known casualty insurance companies have been providing such a policy on request, but they have made no real attempt to sell this form of protection to engineers or architects in general. There is no harmonious meeting of minds among the casualty insurance underwriters regarding the profit opportunities of this coverage. Some prefer to back away from it entirely; others will write such insurance as an accommodation providing they have in their company practically all of the other casualty coverages required by the consulting engineering firm. Even in Texas, casualty companies are writing this risk only sparingly.

Contracts issued have been confined to claims and lawsuits that are the result of bodily injury and property damage. No provision is made for recovery in lawsuits that do not arise of bodily injuries or actual property damage. I have been unable to locate a single contract that would insure a consulting engineer if a suit were to be brought to provide financial comfort to the client as compensation for embarrassment from or dissatisfaction with the engineer's work.

### Design Problem

In the latter part of 1954, in the construction of one of the new, large Eastern hotels, a cantilever balcony appeared faulty in design and strength. Fearing some later collapse, the building superintendent computed the stresses himself and discovered no factor of safety for any extra load beyond the normal. He could not get any satisfaction from the architect-engineers, and to check his own findings, he had an outside consulting engineer make some computations. He came up with the same figures.

Bags of insulation and bronze interior decorative material were then piled on the balcony hoping that it would collapse. Instruments indicated a yield of a quarter of an inch only. The balcony did not give way. Finally, however, the contracting firm, the consulting engineer, and the architect-engineers came to an agreement with the hotel management to pull down the balcony and reconstruct it. Had this not been agreed to, and at some future date the balcony had collapsed injuring hotel patrons, very heavy claims and suits, along with a heavy property damage claims could have been brought against the architect-engineers. If the architect-engineers had insurance, these claims would have been covered.

A market for such protection probably could have been found among the half a dozen companies who have attempted to underwrite such liability. Of course, if they had known of the questionable structural design of the balcony, they would not have passed the risk, but with the voluntary correction and after a general inspection of the premises, the risk would have been acceptable because of the general reliability of the firms involved.

While this coverage can be of value to the consulting engineering profession, it is not welcomed

with open arms by all engineers. There are many who feel that it is not wise to make such insurance available too freely, as it might encourage design engineers to take chances beyond those they would take if they were without insurance coverage.

Engineers well know that there is no longer the margin of safety in construction that there was 50 years ago when building materials and labor were cheap. Today, with high cost of construction, these safety factors are sometimes reduced to a thin margin, and the well-trained insurance engineers who review these risks are well aware of these circumstances.

. . . AND IF THE CABLE BREAKS, YOU GOT NOTHING TO WORRY ABOUT!

This very year many insurance companies have suffered tremendous claims resulting from unknown faults that seem to have developed in some large generators, turbines, and special machines. There is so much new design today that all the stresses involved are not yet known. This seems to be true in civil, electrical, and chemical work as well as in mechanical. Radical innovations in building design and materials of construction naturally make the insurance underwriter and his consulting engineer wary about future disasters.

### Lloyds Is Different

It should be understood that the American insurance industry is not conducted on "chance taking" principles as Lloyds is. Most insurance undertakings are based on carefully assembled statistics. Most insurance falls into "classes," and in addition to what insurance companies might voluntarily care to do, the Insurance Commissioners of each state review these "classes" every five years and have the power to adjust the basic rate structure up or down, according to the five-year experience — good or bad.

To determine whether a line of insurance is to be reasonably profitable or not, an insurance carrier needs both volume and loss experience. Experimenting with a few risks proves little. Unfortunately, the insurance industry has no central research bureau to assemble or test statistics for new insurance ventures, though this has been in the talking stage for some time.

When a consulting engineer seeks protection from future possible claims and suits, the result of faulty design, an astute underwriter will reason in somewhat this manner:

"I don't know enough about the general experience of such suits or claims to promulgate a rate. I am not sufficiently well acquainted with the rapid changes in design to know what is possibly faulty or what is not. And most important to me — can we sell enough of this insurance to establish it as a "class" and take in enough premiums to meet the substantial losses that could develop?"

The underwriter has to ponder the subject beyond this point. Can he get any reinsurance? Being a little afraid of this line, he would like to reinsure the liability with two or three other companies, but he finds no takers. That discourages him from authorizing any substantial limits of liability.

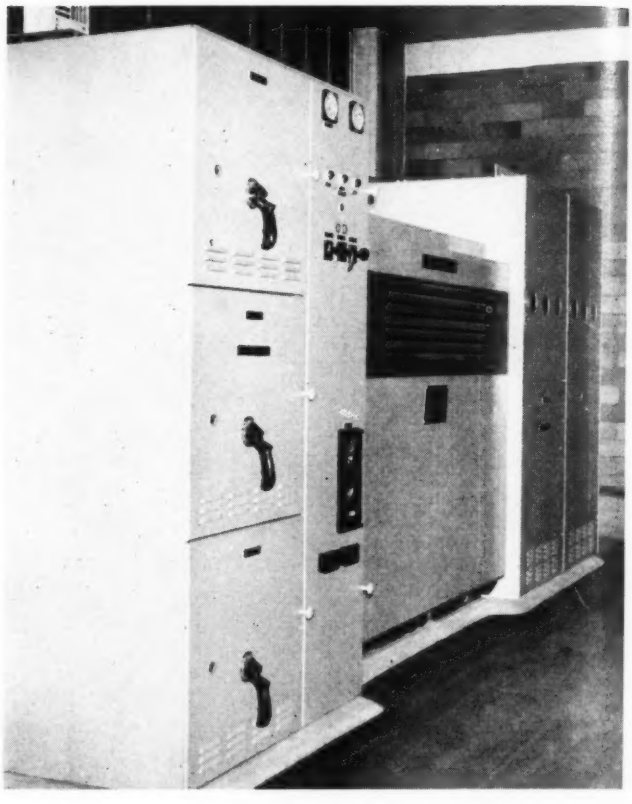
Then, he also knows that this business will be a specialized line. The average agent or broker will not be competent or interested in going out to sell such coverages to consulting engineers. He would not be able to talk their language or to satisfy their inquiries, therefore, this business would never be a big seller, and the volume would be missing.

Of course, he could throw the liability into the "general liability class" and not cut it up as a separate class of insurance. But there is not too much encouragement for the agent here, either. Liability insurance is not as profitable as it once was because of the extremely high awards being granted by courts. General liability rates have practically been doubled.

With Lloyds almost any kind of a coverage can be

*—Continued on page 84*

RIGHT. CENTER SECTION OF THIS MODERN SUBSTATION IS A 1000 KVA, 3 PHASE, AIR COOLED TRANSFORMER.



# Establishing An Industrial Electrical System

HERVE H. HUNT

CE exclusive

THE ELECTRICAL distribution system of an industrial plant must be designed as a foundation for all operations within the plant. Full load demands must be met safely, conveniently, and reliably at the same time that adequate voltage is maintained. Reasonable load growth, load shift, maintenance, local outages, or major disasters must all be accommodated with minimum interruption to service. All this must be accomplished at minimum cost consistent with service continuity.

## Nature of Load

The nature and size of the electrical load must be determined first. If exact data is available, it should be used as a basis for design. Usually, however, load must be estimated. Success or failure will largely depend upon the accuracy and care with which this estimate is developed.

Data such as given in Fig. 1 can be of assistance in estimating a lighting load. Each area of the plant should be considered separately, and the proper factor applied for the type of lighting contemplated. It is not essential that lighting design be completely detailed before the lighting load is estimated. The factors shown in Fig. 1 will generally yield results of acceptable accuracy for determining requirements.

Power loads can be estimated using some factor of volt-amperes per square foot of productive space. Ratios normally range from about 3 va per square foot to as high as 20 va per square foot for some industries. It is best to make a detailed study of representative existing situations. Public utilities and major electrical manufacturing firms have a wealth of such information available. This information also may be available from the engineering divisions of other industries. Fig. 1 also shows representative load data for several types of industries.

Certain items important to electrical system design should be thoroughly considered:

¶ Demand factor — ratio of maximum demand on the system at any one time to total connected load.

¶ Diversity factor — ratio of the sum of individual maximum demands of various sections of the system to maximum demand of the whole system.

¶ Load factor — ratio of average load over a period of time to peak load during the same period.

A system may have a great deal of load connected to it with very little load in use at any given time. This would result in a low demand factor. If different loads are not simultaneously utilized, their demands would not be felt by the system at the same time, and the diversity factor would therefore be high. Furthermore, if the load is generally of a steady nature, without any periods of excessively high demands, the load factor is high. These considerations are very important in defining system capacity and in establishing the best utility service contract. Fig. 1 shows demand factors for certain types of loads.

Demand factors for individual branch circuits serving individual utilization devices should always be designed for 100-percent demand. Demand factors for a feeder serving a number of individual branch circuits for a given area may, for example, be designed to carry only 70 percent maximum demand.

The demand factor for the main feeder serving the plant might be planned to handle as little as 30 percent of the connected load at any one time.

### Power Sources

Having estimated the size and nature of the electrical load, the power source next comes in for consideration. The power will be supplied either from the local electric utility, the plant's own generating system, or from a combination of both.

Where fuel is available as a byproduct of plant production or where the plant uses an appreciable amount of process steam, it may be feasible to install generating equipment to provide electric power for the plant. Decisions should be based on over-all operating costs and not on costs of power alone.

The power supply for an industrial plant should be studied in the following aspects:

¶ Does it have sufficient capacity to supply the maximum demand and still keep up adequate voltage and maintain correct frequency?

¶ How much and what type of power factor correction might be necessary to keep voltages up, currents down, and to satisfy the utility's requirements?

¶ What are the short-circuit capabilities of the supply? (This will determine the class of switchgear equipment necessary and may affect cable size.)

¶ What kind of lightning protection is required?

¶ What is the nominal system supply data — voltage, phase, frequency, number of conductors, wye or delta connection, ungrounded or grounded neutral?

¶ If using in-plant paralleled generators as well as power from a utility, what special relaying will be necessary to prevent feedback of power from the in-plant generators to the utility in the event of a fault on the utility system?

¶ What is the record of service continuity of the utility? (Would it be advisable to provide stand-by generation for the plant?)

¶ What are the terms of the utility service contract? If several supply arrangements are available, which would result in the lowest electric service costs?

The electric utility can answer many of these questions. They are interested in the details of your client's system requirements, since his demands will affect their operations.

### Voltage Levels

The primary voltage at which power enters the plant and is distributed to major substations is determined by the characteristics of the electrical utility supplying the plant. Nominal primary voltages commonly in use in this country are: 2400*, 4160*, 4800, 6900*, 11,500, 12,000, 13,200, 13,800*, 22,900, 34,400, 43,800, 69,000, and 110,000. The asterisk (*) indicates the preferred voltages.

The secondary voltage at which power is distributed from the in-plant substations to the utilization devices is a matter of individual choice, unless the proposed system is an extension of existing facilities.

**POWER REQUIREMENTS FOR LIGHTING**

| Fixture Height | Lighting Demand Factor* Incandescent | Fluorescent |
|---|---|---|
| Below 14 ft | 0.12 | .060 |
| 14 ft to 35 ft | 0.13 | .065 |
| 35 ft to 50 ft | 0.15 | .070 |

*Based on median characteristic fixtures, room width 75 ft, and room length 200 ft or over.

Power required (va per sq ft) = desired illumination intensity (foot-candles) × lighting demand factor.

**ESTIMATED LOAD DENSITIES**

| Type of Plant | Light and Power Demand, va per sq ft |
|---|---|
| Beet sugar factory and refinery | 19 |
| Paper mills | 14 |
| Textile mills, engine builders | 12 |
| Cigarette manufacturing | 11 |
| General manufacturing, chemicals, electronic equipment manufacturing | 10 |
| Small appliance manufacturing, machine repair shop | 7½ |
| Lamp manufacturing | 5 |
| Small device manufacturing | 3½ |

**DEMAND FACTORS**

| Load | Estimating Demand Factor, Percent |
|---|---|
| Motors | |
| 1. General purpose, crane elevators, machine tool, ventilation, pumps, compressors, rolling mills, etc. | 30 |
| 2. Semicontinuous processes, paper mills, refineries, rubber mills, etc. | 60 |
| 3. Continuous operations, textile mills | 90 |
| Resistance ovens, heaters and furnaces | 80 |
| Induction furnaces | 80 |
| Arc furnaces | 100 |
| Lighting | 80 |
| Arc welders | 30 |
| Resistance welders | 20 |

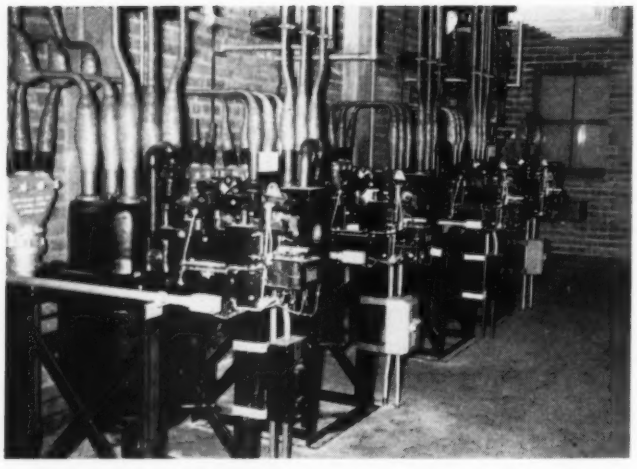
FIG. 1—TABULAR DATA ARE FROM GENERAL ELECTRIC COMPANY'S "INDUSTRIAL POWER-SYSTEMS DATA BOOK."

Nominal secondary voltages commonly in use are:

| Single-Phase | Three-Phase |
|---|---|
| 120 or 120/240* | 120 |
| 240 or 120/240 | 208Y/120* |
| 208Y/120 | 240 |
| | 480* |
| *Preferred | 600 |

The secondary voltage level should be selected in balance against system cost with the following factors important in the choice: size of electric load, feeder lengths, ratings and requirements of standard utilization devices, and safety and code limits.

It is generally impractical to plan secondary utilization above 600 volts unless special load conditions warrant (such as furnace loads or very large motors.) System secondaries rated 240 volts, three-



PART OF RADIAL SYSTEM, SHOWING INDOOR INSTALLATION OF OLD WESTINGHOUSE OIL CIRCUIT BREAKERS.

OLD TYPE SUBSTATION CONSTRUCTION. NOTE OPEN BUS WORK, CABLES, AND EXPOSED TRANSFORMER TERMINALS.

phase, were in vogue for power loads when older plants were built, but 480-volt, three-phase systems are becoming increasingly popular for these reasons:

¶ The cost of a 480-volt system may be approximately 75 percent of the cost of a corresponding system for 240-volt service.

¶ Electric losses and voltage drop in the lines are less for a 480-volt system than they are for a corresponding 240-volt system.

¶ The 480-volt system has been proven to be as safe as the 240-volt system — with proper operating techniques. (No work should be done with the system energized in either voltage class.)

Systems rated 600 volts are not generally employed because standard utilization equipment is not readily available. Furthermore, the difference between 600 volts and 480 volts is not sufficient to constitute a clear-cut advantage. Three-phase power is used in preference to single-phase for main distribution since the current corresponding to any given load is significantly lower. Single-phase power is generally limited to small hand tools and highly specialized applications.

Where lighting loads constitute a major portion of the total plant load, and where a large number of hand tools and small- or moderate-size motors are employed, a 208Y/120-volt, three-phase, four-wire, wye-connected system may be practical. This will result in a near-perfect balance of lighting load on the feeders, will allow the advantage of three-phase distribution to the single-phase lighting load, and will provide a moderate amount of three-phase power.

Lighting and power loads can also be combined on a 480Y/277-volt, three-phase, four-wire, wye-connected system using lighting fixtures and control switches approved for 277-volt service. This type of system should be utilized only where access to the lighting fixtures is limited to qualified personnel. High-bay lighting installations are particularly well adapted for this type of system.

An infinite variety of circuit arrangements are possible. Each offers individual advantages with respect to cost, flexibility, simplicity, service continuity, and maintenance. The radial system is the simplest circuit arrangement possible. All power delivered to any particular secondary substation and the loads it serves can come through but one path. In most instances, this will be the least expensive system. It will combine operating safety and simplicity with as high a degree of reliability as most ordinary situations demand. However, no power can be delivered to a secondary bus if any of its corresponding primary facilities are out of service.

### Primary Selective System

With a primary selective system, two primary sources are brought to each substation, with switching to allow selection between the primary sources. This system offers the advantage of reliability at the primary level, and permits maintenance on the primary zone of the system without shutting down any of the secondary zone. The primary selective system may cost from 15 to 40 percent more than a corresponding radial system.

### Secondary Selective System

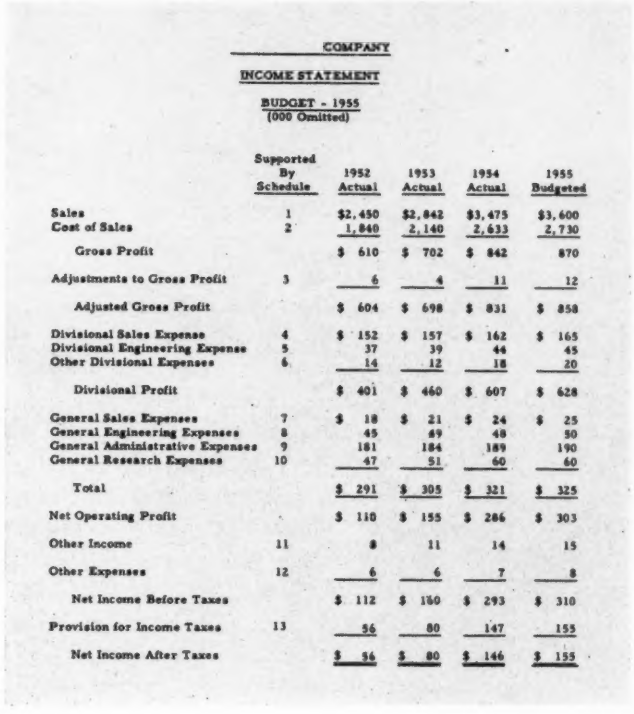
The secondary selective system is characterized by an open tie line between the secondaries of one or more substations. Each substation normally operates independently of the others. In event of a shutdown of a primary circuit or of a transformer, however, secondary power can be delivered to the affected secondary bus from a neighboring substation through the secondary tie line. The principal advantage of this system is that one primary and one transformer can be shutdown in any substation, and secondary power can still be supplied to the loads on the corresponding secondary bus.

In this system, there will be occasions when one

*—Continued on page 82*

**HENRY KEYSERLING**
**Associate**
**Cresap, McCormick and Paget**

Henry Keyserling is with the management consulting firm of Cresap, McCormick & Paget in New York. He specializes in the field of management and financial controls and organizational problems. Formerly affiliated with Booz, Allen & Hamilton of New York, on his own in management consulting, and in public accounting with Haskins & Sells and Price Waterhouse & Co., his broad professional background is balanced by experience in actual operating capacities. He started his business career with the Swedish Match Company in sales and production, and has held senior financial positions in other companies, including that of vice president and controller with the Plymouth Cordage Company. Mr. Keyserling directed the American Management Association's seminar last year on budget preparation, and he is an active member of the Controllers Institute of America.



_____ COMPANY

INCOME STATEMENT

BUDGET - 1955
(000 Omitted)

| | Supported By Schedule | 1952 Actual | 1953 Actual | 1954 Actual | 1955 Budgeted |
|---|---|---|---|---|---|
| Sales | 1 | $2,450 | $2,842 | $3,475 | $3,600 |
| Cost of Sales | 2 | 1,840 | 2,140 | 2,633 | 2,730 |
| Gross Profit | | $ 610 | $ 702 | $ 842 | 870 |
| Adjustments to Gross Profit | 3 | 6 | 4 | 11 | 12 |
| Adjusted Gross Profit | | $ 604 | $ 698 | $ 831 | $ 858 |
| Divisional Sales Expense | 4 | $ 152 | $ 157 | $ 162 | $ 165 |
| Divisional Engineering Expense | 5 | 37 | 39 | 44 | 45 |
| Other Divisional Expenses | 6 | 14 | 12 | 18 | 20 |
| Divisional Profit | | $ 401 | $ 460 | $ 607 | $ 628 |
| General Sales Expenses | 7 | $ 18 | $ 21 | $ 24 | $ 25 |
| General Engineering Expenses | 8 | 45 | 49 | 48 | 50 |
| General Administrative Expenses | 9 | 181 | 184 | 189 | 190 |
| General Research Expenses | 10 | 47 | 51 | 60 | 60 |
| Total | | $ 291 | $ 305 | $ 321 | $ 325 |
| Net Operating Profit | | $ 110 | $ 155 | $ 286 | $ 303 |
| Other Income | 11 | 8 | 11 | 14 | 15 |
| Other Expenses | 12 | 6 | 6 | 7 | 8 |
| Net Income Before Taxes | | $ 112 | $ 180 | $ 293 | $ 310 |
| Provision for Income Taxes | 13 | 56 | 80 | 147 | 155 |
| Net Income After Taxes | | $ 56 | $ 80 | $ 146 | $ 155 |

## A tool for you and your client ...

# The Operating Budget

CP exclusive

WHY IS BUDGETING of interest to a consulting engineer? For one thing, a consulting engineer's own business certainly is one of the more difficult to budget. For that very reason, consulting engineers who will adopt (or already have adopted) this tool for managing their own business will find themselves better organized and better able to meet sudden and changing demands. The competition and pressure of contemporary business make it clear that survival no longer can be assured by merely meeting today's problems. The successful business looks into the future, charts a course in the form of a budget, and then makes every effort to accomplish its long-range programs.

There is still another reason. If you are to provide real service to your clients, and are to be recognized as capable of rendering a service beyond the specialized engineering phase of your work, then a better understanding of budgeting is necessary. Consulting engineers must understand how budgets are prepared and what information a client requires to prepare a successful budget—a budget that is both realistic and yet sufficiently detailed to become a real working tool. Information must be projected about the cost of new projects, the returns that can be expected, the changes in facilities needed to improve productivity and cost, and so on for the entire range of consulting engineering services.

Because so many engineers still consider budgeting as something in the category of a crystal-ball operation, they have relied on two old yardsticks—neither having much value as objectives in themselves. The first is a comparison of current performance with some prior period. If present performance is better, they are reassured that they are on the right track. The second yardstick is a comparison of current ratios with those of the past.

Although past performance records are of great value, a constant comparison with the past completely neglects to establish how well performance stacks up against actual capabilities. What we really want to know is whether we are doing as well as we should. Determining whether we did better or worse than last year is only a partial answer. A recent comparison of operations of two companies in similar industries showed that while one had increased its operations by 60 percent since 1945, the other had increased 345 percent. Both managements had done better in comparison with prior periods. But the question as to how much better they should have done is left unanswered.

It is to answer just this question that the technique of budgeting has been developed. It not only establishes the objectives of a company, but (properly drawn up) provides both a constant and a continuous measure of performance to help manage-

ment direct and control operations. These benefits of budgeting can be summarized as follows:

¶ Budgeting establishes firm objectives. These take into account past operations, but will also include new plans and management's appraisal of general business conditions for the coming period.

¶ It provides, in advance, a clear statement of objectives for everyone in the organization, giving them a specific guide in discharging responsibilities. Properly set up, a budget provides this guidance at each level of management.

¶ It provides a measurement of performance in advance. This minimizes the need for management to control all operations constantly and directly. The budget provides this control automatically.

¶ A budget once established is easy to administer. Causes for variations from the budget are readily identified. The need is eliminated for constantly reexamining prior year performances, and making mental or actual adjustments to past performance. This was done when the budget was established. Deviations now reflect only current conditions.

### Organizing Budget Preparation

Basically, the approach to budget preparation is the same as for the preparation of yearly reports. The difference is that annual reports are based upon details of operations that already have taken place. The budget takes each one of these operations and estimates what they will be for the coming year. Thus, the budget is not a generalized forecast. Rather, it is a very specific, detailed forecast of every known factor that contributes to the total operation. It is for this reason that past records and experience are important as a basis for developing budget information. But the past records are important only as a basis upon which to build.

The greater the detail, the better the budget. This statement is almost axiomatic. It is based upon a principle that consulting engineers should understand readily. It is founded on the law of averages; though not all parts of the budget can be correctly forecasted, no single factor would be sufficiently significant in contributing to over-all error if enough factors are included. Success in budgeting is closely related to the detail with which it is prepared.

Certain steps in budgeting are of particular importance. They form a specific basis upon which to launch the preparation of the operating budget and to insure its success. The first is the designation of a budget director, who not only is familiar with accounting and budget preparation techniques, but who also is familiar with the operations of the firm. It is better that he lack complete knowledge of accounting operations than to be lacking in full understanding of the firm's operations.

The next step is to establish the length of the budget period. Customarily, an operating budget covers a period of 12 months. It frequently is prepared for shorter periods, or the 12-month period may be divided into quarters. It also is quite customary today for budgets to be revised, usually not more frequently than once each quarter. These revisions include the changes management foresees in the remaining months of the budget period, and frequently a forecast for an added three months.

Thus, there is always a 12-month budget against which to operate, and the closest months are likely to be most accurate. This is known as a "rolling" budget. One further advantage is that it helps keep management constantly alert to future trends, so operations can be adjusted on an orderly basis.

### Basic Premises

When preparing an operating budget, a number of factors require management consideration, but the following seven are the most common:

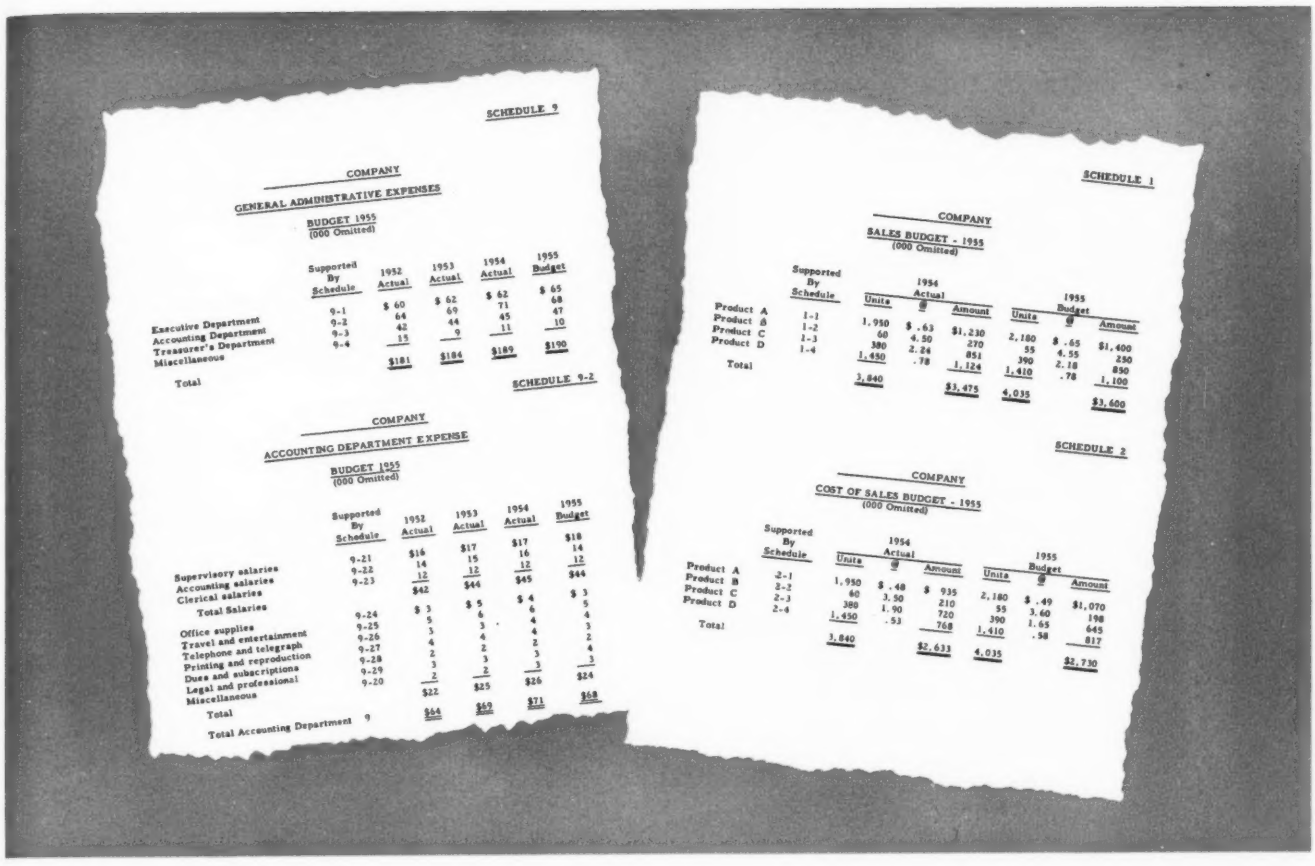
¶ Profit Objective. A profit objective for the coming year should be clearly established. This may be based upon a return on investment, meeting a dividend policy, or it may be conditioned upon general industry-wide profit margins. This also should include considerations of possible financing, borrowings, debt repayment, and capital needs that may be expected to influence profitability.

¶ Economic Forecast. Management must come to some conclusions as to the general economic outlook. These should include the country as a whole, and its specific field of business.

¶ Plant Program. Facilities available for production in the coming budget period should be analyzed. If a bigger market is expected, should present facilities be expanded? If so, when will the new capacity become available? Can additional production be secured through subcontracting? Are there facilities already under construction that will come into production during the budget period? Decisions in this area are of great importance. They may involve financing problems. They will require careful study of the immediate budget period, and the longer range, to determine if the expansion will be permanent. Then too, perhaps some facilities have become obsolete and should be abandoned.

¶ Sales Prices. Tied closely to the economic forecast is the question of selling prices for the budget period. Are prices going to be steady? Will they decline or go higher? If changes are expected, when will they take place? This is a difficult forecast to make at times. Experience shows that, under normal circumstances, selling price forecasts can be relatively accurate. There is past history to go on, past price swings can be studied, and industry pricing practices can be evaluated thoroughly.

¶ Purchase Price. Similarly to selling prices, prices for raw materials must be forecast for the budget period. In many industries, this is not as difficult as forecasting selling prices. Raw materials prices tend to be more stable. Many raw materials are pur-



SCHEDULE 9

COMPANY

GENERAL ADMINISTRATIVE EXPENSES

BUDGET 1955
(000 Omitted)

| | Supported By Schedule | 1952 Actual | 1953 Actual | 1954 Actual | 1955 Budget |
|---|---|---|---|---|---|
| Executive Department | 9-1 | $ 60 | $ 62 | $ 62 | $ 65 |
| Accounting Department | 9-2 | 64 | 69 | 71 | 68 |
| Treasurer's Department | 9-3 | 42 | 44 | 45 | 47 |
| Miscellaneous | 9-4 | 15 | 9 | 11 | 10 |
| Total | | $181 | $184 | $189 | $190 |

SCHEDULE 9-2

COMPANY

ACCOUNTING DEPARTMENT EXPENSE

BUDGET 1955
(000 Omitted)

| | Supported By Schedule | 1952 Actual | 1953 Actual | 1954 Actual | 1955 Budget |
|---|---|---|---|---|---|
| Supervisory salaries | 9-21 | $16 | $17 | $17 | $18 |
| Accounting salaries | 9-22 | 14 | 15 | 16 | 14 |
| Clerical salaries | 9-23 | 12 | 12 | 12 | 12 |
| Total Salaries | | $42 | $44 | $45 | $44 |
| Office supplies | 9-24 | $ 3 | $ 5 | $ 4 | $ 3 |
| Travel and entertainment | 9-25 | 5 | 6 | 6 | 5 |
| Telephone and telegraph | 9-26 | 3 | 3 | 4 | 4 |
| Printing and reproduction | 9-27 | 4 | 4 | 4 | 3 |
| Dues and subscriptions | 9-28 | 2 | 2 | 2 | 2 |
| Legal and professional | 9-29 | 3 | 3 | 3 | 4 |
| Miscellaneous | 9-20 | 2 | 2 | 3 | 3 |
| Total | | $22 | $25 | $26 | $24 |
| Total Accounting Department | 9 | $64 | $69 | $71 | $68 |

SCHEDULE 1

COMPANY

SALES BUDGET - 1955
(000 Omitted)

| | Supported By Schedule | 1954 Actual Units | @ | Amount | 1955 Budget Units | @ | Amount |
|---|---|---|---|---|---|---|---|
| Product A | 1-1 | 1,950 | $ .63 | $1,230 | 2,180 | $ .65 | $1,400 |
| Product B | 1-2 | 60 | 4.50 | 270 | 55 | 4.55 | 250 |
| Product C | 1-3 | 380 | 2.24 | 851 | 390 | 2.18 | 850 |
| Product D | 1-4 | 1,450 | .78 | 1,324 | 1,410 | .78 | 1,100 |
| Total | | 3,840 | | $3,475 | 4,035 | | $3,600 |

SCHEDULE 2

COMPANY

COST OF SALES BUDGET - 1955
(000 Omitted)

| | Supported By Schedule | 1954 Actual Units | @ | Amount | 1955 Budget Units | @ | Amount |
|---|---|---|---|---|---|---|---|
| Product A | 2-1 | 1,950 | $ .48 | $ 935 | 2,180 | $ .49 | $1,070 |
| Product B | 2-2 | 60 | 3.50 | 210 | 55 | 3.60 | 198 |
| Product C | 2-3 | 380 | 1.90 | 720 | 390 | 1.65 | 645 |
| Product D | 2-4 | 1,450 | .53 | 768 | 1,410 | .58 | 817 |
| Total | | 3,840 | | $2,633 | 4,035 | | $2,730 |

GOOD OPERATING BUDGETS INCLUDE ADMINISTRATIVE EXPENSE AND SALES FORECASTS PLUS A PRODUCTION BUDGET.

chased on long-term contracts or contracts that include price-protection clauses.

¶ Wage and Salary Policy. In many industries, wages and salaries constitute a very large part of total costs. As a consequence, management's policy for the budget period is of great importance. What union contracts are up for renewal during the period? What will management's policy be in respect to them? What is the present pay level, and is it likely that revisions will be made during the coming year? What changes are contemplated in the company's pension, vacation, and insurance plans?

Management is often reluctant to incorporate expected wage and salary increases into operating budgets for fear of stirring up hopes and weakening their position at the bargaining table. For operating budgets to be realistic, however, proper balance must be maintained between expected selling price and production cost. This is a delicate question. The problem has less significance if a "rolling" budget is used because adjustments for higher wages and salaries need not be reflected quite so far in advance (provided selling price levels also are restricted).

¶ Expense Policies. Budgeting should anticipate any special programs involving unusual expenditures or retrenchments. A good example would be a special advertising campaign to promote a new product, or a drastic curtailment in advertising upon abandonment of an old product. Likewise, there may be programs for the addition of new sales branches or a major repair project. These must receive proper recognition when preparing the operating budget.

Once all these and any other known factors have been established by management, work can be started upon the more detailed phases of budget preparation. This work naturally breaks down into three principal areas: sales forecast, production budget, and selling and administrative expense forecast.

### Sales Forecast

The sales forecast must involve more than deciding upon next year's total sales. It involves a very detailed analysis of expected sales. It is here that the greatest care is required. It is also here that the law of averages can be of greatest assistance. Accuracy is directly correlated with the depth of detail into which the forecast is broken down by products, by sizes and kinds, and by territories and salesmen. Past sales statistics are of great value here. Consideration also should be given to the share of market expected, activities of competitors, possible new competitive facilities, changes in tariffs if foreign imports are a factor, and every other known factor likely to have a bearing upon the total sales during an ensuing period.

This phase of budget preparation should be a joint effort of the entire sales force with each salesman preparing a forecast for his own territory. Through

progressive steps of review and consolidation, the over-all forecast can then be made. When a sales forecast is prepared literally from the bottom up, the margin of error is not too great.

### Production Budget

In order to translate the sales forecast into a production budget (which now should be available in complete detail), consideration must be given to the year-end inventories on hand and to management's policy about expected inventory levels at the end of the budget period. Total forecasted sales plus opening inventories less closing inventories then will represent the production required.

The sales forecast also should incorporate a time schedule. Some products are needed seasonally. Others have steady sales throughout the year. Based upon this time factor, the most economical production schedule can be developed. Having an established production schedule, the budget director can proceed with the building of expense budgets that incorporate the known production expenses and include any anticipated unusual conditions.

Many companies today use a system of standard costs. Such companies should check their standards carefully to make certain that changes in manufacturing costs are reflected properly in the standards. Likewise, some companies use a variable system of budgeting. This means that production expenses are not based upon the sales forecast, but upon a normal production quantity—a quantity management considers normal or ideal in the light of available facilities, market, and the most economical production cost.

The total costs then are divided between continuing expenses that do not change with production volume (such as insurance, depreciation, and perhaps supervision), and those that vary directly with production volume (such as direct labor and power). This permits a monthly calculation of expense allowance as a measure of manufacturing performance, based upon one-twelfth of the continuing expenses, plus the proper amount of the variable components. This refinement permits more rapid comparisons between budget forecasts and actual results. Control is simplified.

### Selling And Administrative Expenses

Lastly, estimates can be prepared of the selling and administrative expenses for the budget period in the light of the expected sales, the kind of selling program, and the required manufacturing program. Here again, past statistics are of great value, as these expenses are less subject to periodic change.

### Putting The Budget Together

The budget director's next task is to pull all data together (by preparing what virtually amounts to an operating statement and balance sheet), based upon the sum of the various forecasts. This, like the annual statement, may reveal conditions that are considerably at variance from the profit objectives established earlier. In other words, the budget cannot be met as planned. Any number of factors can have contributed to this condition. However, unlike the annual report, it is not yet too late to develop plans to correct this condition. This is the most important, and final, phase of budget preparation.

### Budget Review

The budget director examines the causes that could have contributed to the disparity between the actual and the forecasted operations. He studies each of the contributing areas to determine what changes and improvements can be undertaken to approach the desired over-all result more closely.

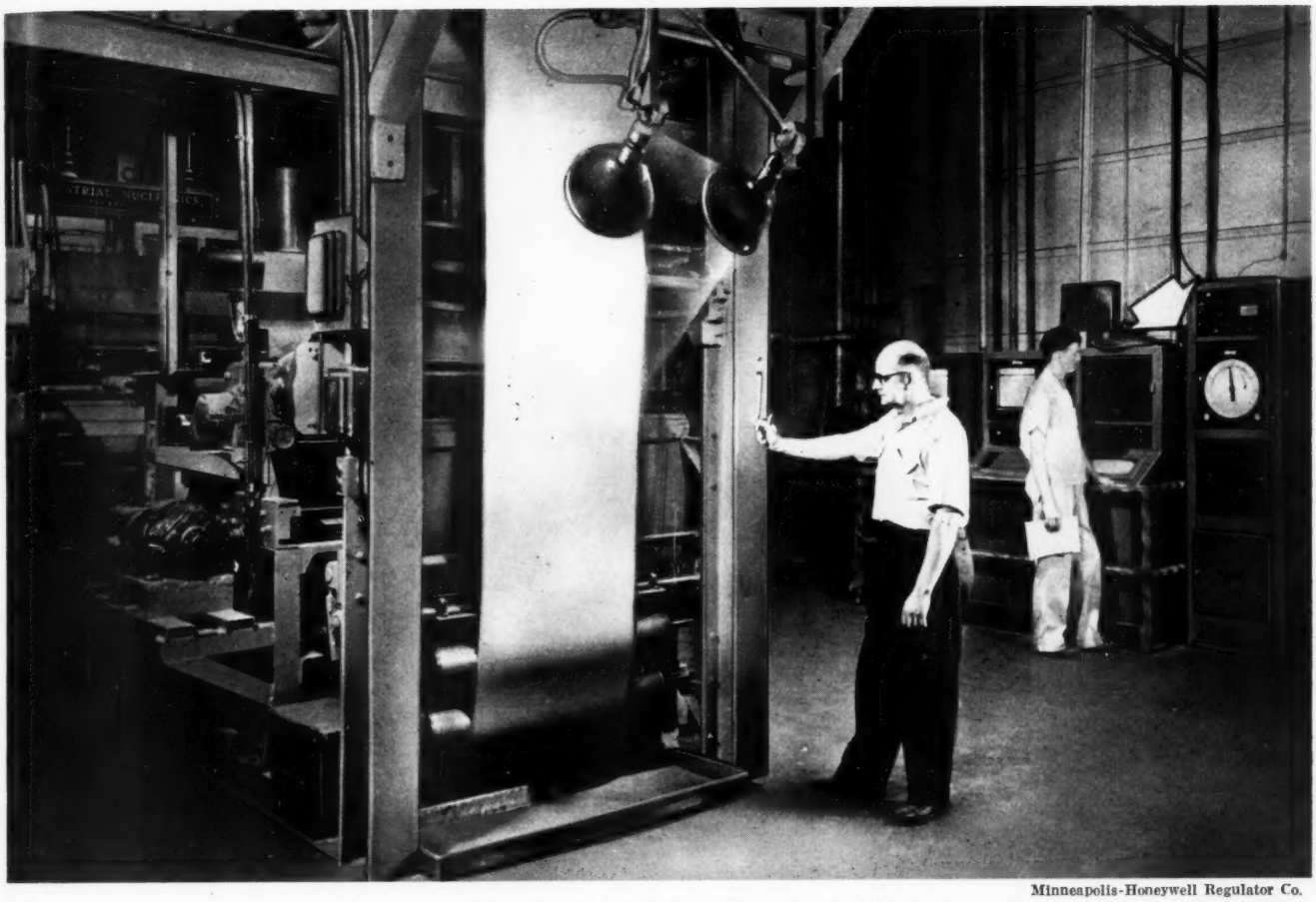
The solution may rest on postponement of some major programs, or on a shift in emphasis in the sales effort. The solution may lie in a combination of remedies. Finally, however, management has to satisfy itself that everything that can be done is being done—even if the profit objective needs revision. The operating budget from here on becomes the official yardstick by which performance will be measured. No longer does a need exist to compare with prior-year results, since these have already been recognized in preparing the budget.

### Dangers In Budgets

There are certain dangers in budget preparation. It is only human to try and improve over whatever objectives have been established. We try to do better tomorrow than what we did today. Tempering this drive however, should be a streak of caution which urges us to avoid promises that might be hard to keep. In fact, a conservative promise might make an average improvement look good, even though a far better improvement was possible.

Every budget director must be on the alert to prevent the budget from containing extremes of optimism or of caution. This is where records of past performance are of help. Another danger is the tendency to hurry up the budget-building process, and to omit sufficient detail. This not only makes errors possible, but makes the identification of these errors more difficult later.

Although the preparation of the first operating budget may not result in a perfect score, such a budget will yield real benefits. The very process of preparation will have brought about a review of all phases of the firm's activities. It will have forced the resolution of policy and other problems that normally would have been left until the next emergency or crisis. It will have drawn in all areas of management, and thus contributed to strengthening the company's *esprit de corps*. As budget preparation experience grows, so will the accuracy with which the forecasts are made. ▲



Minneapolis-Honeywell Regulator Co.

TO APPLY ABRASIVES UNIFORMLY, CARBORUNDUM CO. USES ELECTRONIC COMPUTER TO CONTROL ADHESIVE VISCOSITY.

CE exclusive

# What It Takes To

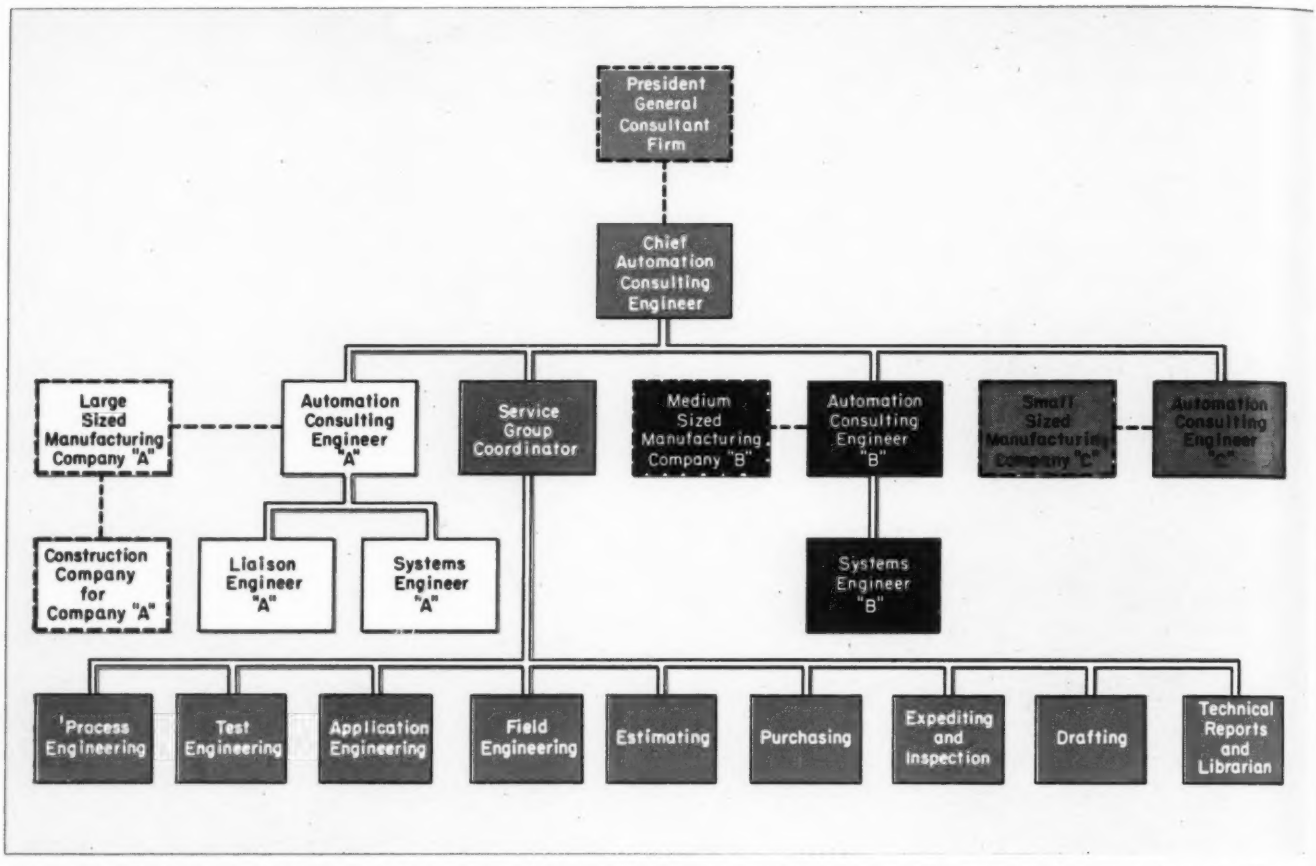
# Consult In Automation

**HERBERT S. KINDLER**
**Consulting Engineer**

Mr. Kindler has been working with instrumentation and automation since his graduation as an ME from Massachusetts Institute of Technology. He has been affiliated with the James P. O'Donnell Company, the Brown Instruments Division of Minneapolis-Honeywell Regulator Company, and with the Catalytic Construction Company. He recently founded his own consulting practice in Philadelphia. Presently, he is control consultant to Black, Sivalls & Bryson, Inc., Oklahoma City, Oklahoma. Mr. Kindler is a registered professional engineer in New York.

HOW CAN consulting engineers best serve clients who have expressed interest in automation for their plants? What is necessary for a consulting engineer to work in automation? Consider what a paradox an automation consultant must be. His specialized knowledge must encompass the theoretical aspects of feedback control loops, determinations of system stability, and dynamic system synthesis. He also must have practical knowledge of how each specific manufacturers automation equipment will perform under a wide range of applications.

On the other hand, the consulting engineer in automation must be a jack-of-all-trades in the engineering sciences. His general knowledge must include the mechanical engineer's understanding of machinery, piping, pumps, turbines, boilers, and similar equipment. He must have the electrical




AUTOMATION STAFF MAY BE SET UP LIKE THIS, WHETHER IT IS A SEPARATE FIRM OR IS PART OF A LARGER ONE.

engineer's comprehension of complex instrument circuitry, the chemical engineer's process background, the metallurgist's ability to select appropriate materials, the accountant's appreciation of cost and amortization, and executive's knowledge of profitable enterprise.

To the general engineering consultant, it may appear that the job of acquiring this assortment of knowledge is too much for any one man. However, there are engineers who possess all these attributes of the automation engineer. There is a growing corps of these specialists evolving from among the instrument engineers of large industries and engineering-contractor firms.

### The Organization

The general engineering consultant faced with client demand for service in automation has to decide whether he should collaborate with an existing firm of automation consultants or establish an automation wing on his own firm's organization chart. Either way, the realm of the automation experts may look like that shown on the above chart. The chart indicates the structure of an automation consulting staff. It shows the relationship between its members and indicates how they function to serve the needs of a client.

The automation consulting engineers "A", "B", and "C" are each responsible for the progress and satisfactory completion of individual projects. They help the client formulate a unified automation philosophy, employing an up-to-date book of standards. On smaller projects, they also perform the functions of the systems engineers and liaison engineers.

The systems engineers "A" and "B" analyze overall system performance, enabling them to issue impartial specifications which insure that all component process equipment will be responsive to automatic control. They could also function within the client's organization, if desired, to coordinate automation design with piping, vessel, electrical, structural, equipment, and process design.

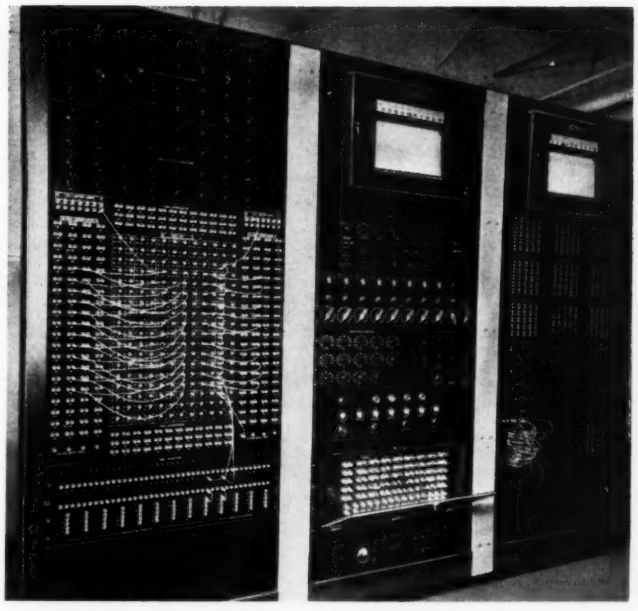
A liaison engineer "A" is assigned to those projects that involve construction companies, and he serves as a liaison between the construction firm and the client. Thus, construction progress is speeded by having a single, responsible liaison source of information. Weekly reports of all significant decisions are issued to the client, and all pertinent client comments are thereby obtained. The liaison engineer is further charged with follow-up of quotations, purchasing, drafting, shipment to job site, inspection, installation, and start-up. He also supervises the compilation of instruction and maintenance manuals, including drafting of a list of parts to be stocked by the client's instrument repair group.

Of the service groups, the two that deserve particular attention are the Test and Application En-

gineering sections. The Test Engineering section maintains laboratory facilities to objectively compare competitive equipment, particularly stressing investigation of those design features most important to the client's specific application. Tests are conducted both in the laboratory (where the tested equipment can be readily subjected to extreme process variables), and in the field (where tested equipment can be examined under actual operating conditions). Some development work is done, but it is limited primarily to modifying existing commercial devices for the clients' special applications.

The Application Engineering section maintains complete files on the commercial availability of automation equipment. These must be periodically brought up to date. Upon disclosure of a new automation product, two steps are taken to be certain that all clients have the opportunity of utilizing the most current devices on the market. First, the records of inactive projects are examined for potential uses of the new equipment. Second, new equipment disclosures are circulated to all consulting engineers on active projects for their possible application in the system design.

If new equipment appears to have substantial advantages to a client, he is so advised. If some modification would make the new product valuable to a client, the director of the Test Engineering section consults with the manufacturer to determine the feasibility, delivery, and cost of such modifications.



GULF OIL AUTOMATICALLY COMPUTES OPTIMUM OPERATION OF OIL WELLS DURING PRODUCTION.

The services offered by the automation consultant and the character of his organization will undoubtedly become increasingly important to the general consultant—whether the two operate as separate groups allied for the purposes of given projects or whether they exist together under the same roof as parts of a single firm. ▲▲

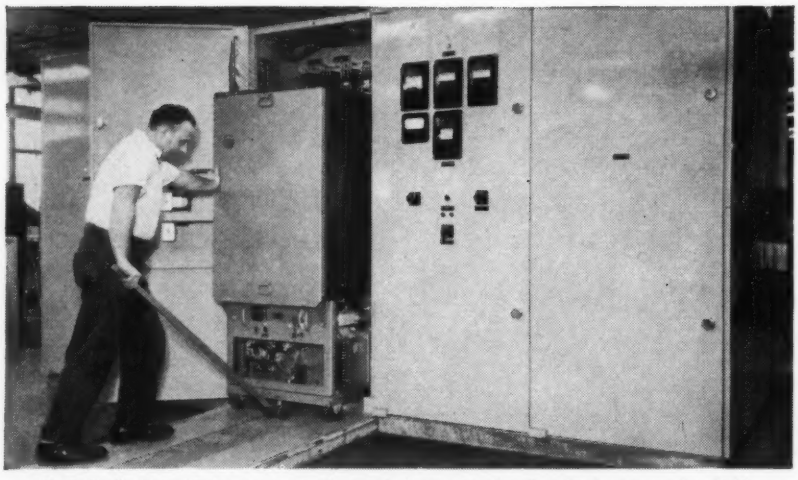
## CE quotes - -

*TO SOME people, Automation means mechanization, to others material handling, and to still others, the automatic factory — words that conjure up visions of robots running machines and factories without men. Actually, these words have little or no bearing on the industrial concept of Automation today. . . . Today's industrial interpretation of Automation is continuous automatic production. It is a way of manufacturing based on the continuous flow concept, rather than the batch concept. As such, it has developed beyond the relatively limited definition of a few years ago — automatic handling — and today embraces all the manufacturing operations — making, inspection, assembling, testing, and packaging. This concept will have a direct and marked effect on our labor, manufacturing facilities, products, and profits during the years ahead. . . .*

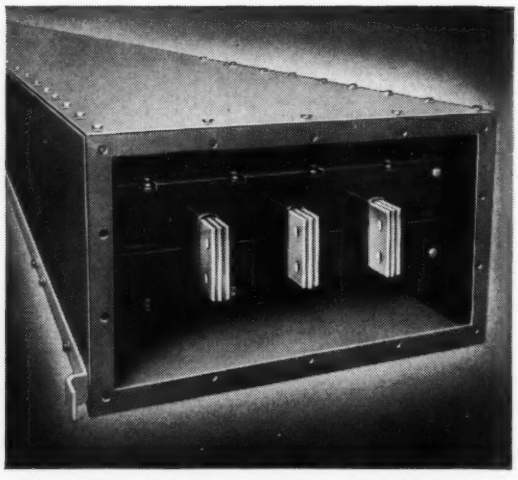
*There is a place for Automation in each of our businesses — large or small. The extent to which it can be applied economically is determined, not by the size of the business, but rather by the volume and nature of the products manufactured. In job shop functions, there are often some high-volume operations (with many manual operations) that lend themselves to automatic manufacturing methods. While we have been looking at Automation at the product level it generally takes place several steps below that level. In other words, Automation is generally applied to components and subassemblies of a complete product. For instance, even with low-production items, such as large motors, the production of laminations — which is high — may be automated. Another example, would be a turbine blade in a jet engine. Here, the production of jet engines is low but the number of turbine blades required per engine is high. . . .*

*There is no longer any question as to whether American industry will automate. Instead, the question is . . . how much and how soon? Are you going to "lead the parade, or follow it?"*

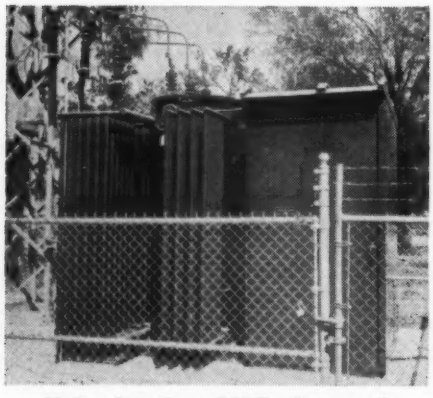
P. H. Alspach
Manager — Manufacturing Development
General Electric Company



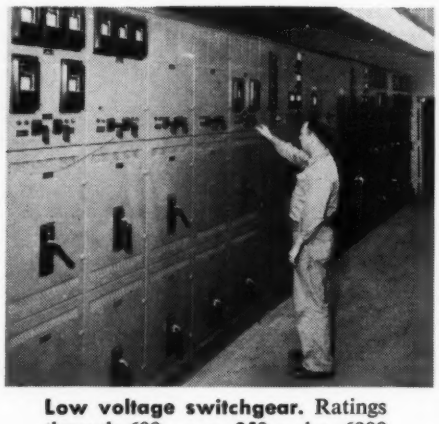
**Metal-clad switchgear.** Horizontal drawout air circuit breakers in rigid, all-welded enclosures. Available in ratings from 2400 v through 15 kv—50 through 500 mva interrupting and 2000 amp continuous.



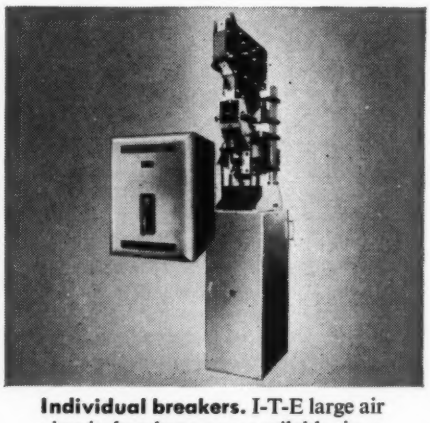
**Nonsegregated phase, metal-enclosed bus.** For switchgear connections. In ratings 600 v through 6000 amp; 5, 7.5 or 15 kv through 5000 amp.



**Unit substations.** I-T-E primary and secondary unit substations can be supplied for any application—indoor and outdoor—and in any standard rating.



**Low voltage switchgear.** Ratings through 600 v a-c, 250 v d-c, 6000 amp continuous, 15,000 through 150,000 amp interrupting.



**Individual breakers.** I-T-E large air circuit breakers are available in a wide range of types and ratings, 600 v a-c, 250 v d-c, 750 v d-c.

# NEW CONSTRUCTION ECONOMY TIP: BUY AN I-T-E "POWER PACKAGE"

## Coordinated engineering, delivery and installation means a better investment

An I-T-E "power package" includes the complete power handling facilities you need for a new construction project, building addition, or simple expansion of electrical service—one unit or a complete system for application from generation to end use. You save many ways:

**Sound planning.** Talk with your local I-T-E application engineer about your general power requirements before you build. He'll work with you to determine the equipment needed to assure complete protection with greatest economy in total investment, operating costs, and construction time.

**Easier installation.** Before you begin construction, I-T-E will supply you with arrangement and channel base drawings. Equipment is factory assembled, tested and ready to install. Standardized frames and panel elements assure that future additions to your switchboard will match and line up.

**Coordinated delivery.** Shipments are made from I-T-E according to a predetermined schedule. Each part of the complete "power package" is delivered to the job when needed. This saves delays and eliminates inconveniences.

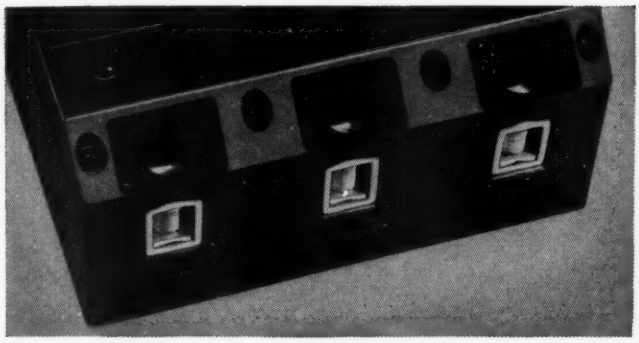
**Assured performance.** Since I-T-E will supply all equipment—pre-engineered—you are saved the work of coordinating equipment of different manufacture. You can be sure that the separate parts of an I-T-E "power package" will fit and function together.

For details, contact the I-T-E sales office nearest you—look in your classified directory under "Electric Equipment." I-T-E Circuit Breaker Company, 19th & Hamilton Sts., Philadelphia 30, Pa.

I-T-E

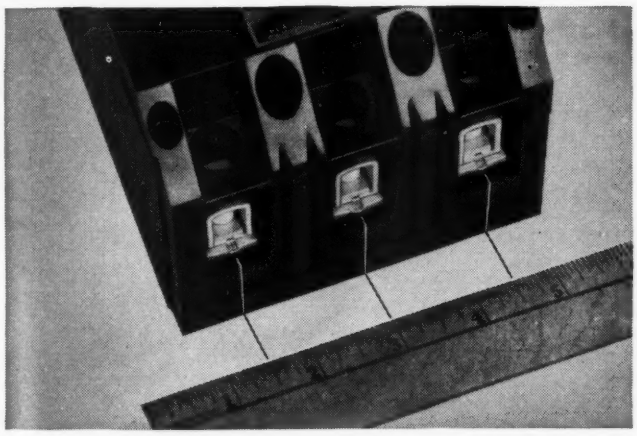
**I-T-E CIRCUIT BREAKER COMPANY**
**Switchgear Division**

# I-T-E Molded Case Circuit Breakers Offer You These Extra Values



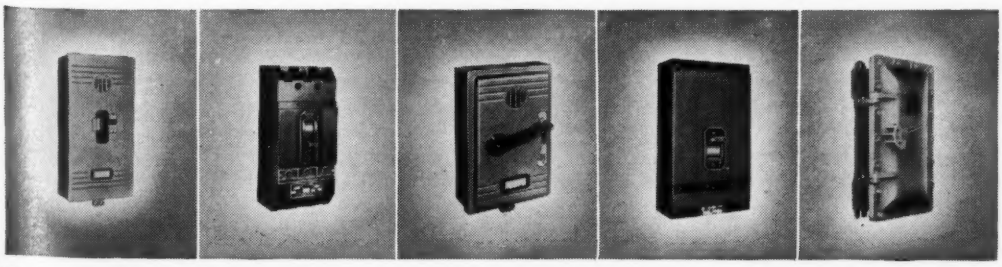
**1. Enclosed terminals.** Provide maximum safety to personnel, yet permit ease of cable connection. All 600 v a-c rated I-T-E molded case breakers have enclosed line and load terminals.

**2. External instantaneous trip adjustment.** Accessible from front of breaker. Adjustment can be changed to desired setting after breaker is installed without removing cover or disrupting service.



**3. Greater terminal clearance.** I-T-E molded case breakers are designed on multiple 1½" pole centers to provide maximum phase to phase spacings and reduce electrical leakage clearance problems.

**4. Plug in mounting.** I-T-E molded case breakers can be readily equipped with tulip clip adaptors and molded mounting block for maximum flexibility when changing and installing breakers.



**5. A complete line.** I-T-E manufactures a complete line of commercial, Navy and maritime molded case circuit breakers 10 through 600 amp, 600 v a-c, 250 v d-c. All are available with various special features and in all types of individual enclosures.

Contact your I-T-E representative or authorized distributor for the Speedfax Catalog—containing complete information on all I-T-E circuit breakers and enclosures. Or, if more convenient, write Small Air Circuit Breaker Division, I-T-E Circuit Breaker Company, 19th and Hamilton Streets, Philadelphia 30, Pa.

**I-T-E CIRCUIT BREAKER COMPANY**

**Small Air Circuit Breaker Division**

## Plant-location news

# Get facts on water . . . fast and free

You should see the letters we get from plant-location specialists who received water data from our Industrial Location Service. These people say they never got so much comprehensive, up-to-the-minute information so fast. Or information that was more helpful in choosing the *right* plant site for their clients.

One reason we can supply just this kind of authoritative material is the *way* ILS specialists work. They collect and analyze facts from a variety of sources to meet the specific needs of people requesting information.

### Water, water everywhere . . .

I remember one ILS water report prepared for an engineer assisting a large producer of industrial chemicals. It ran over 25 pages with maps and diagrams and aerial photos—and covered just about everything.

It pinpointed surface-water supplies of the correct quantity and temperature range. And a chemical analysis checked on quality. Not just total hardness and pH, but quantities of silica, iron, molybdenum, calcium, magnesium, and other elements had been measured. Specific conductance had been determined, too.

But in case surface water wasn't enough for this chemical company, ILS went *below* ground in selected areas. They surveyed water-table records, logs and production capacity of local wells, and made the *same* chemical analysis as they did for surface supplies.

All this detailed information was in the final report, along with a number of suggested locations having just the right water sources. And like all ILS reports, this one was prepared free of charge.

### Other free plant-site services

Water won't be your only concern when you're checking on new plant locations for clients. But no matter what factors are involved, ILS can help. Reports are available on transportation, markets, raw materials, labor, buildings or sites, and local laws and regulations—for a variety of New York State locations. All these surveys are tailored to meet whatever requirements you outline. And they're sent to you without cost or obligation in strictest confidence.

Our booklet called "Industrial Location Services" shows how you can put this valuable plant-location data to work in preparing accurate, comprehensive reports. To get your free copy, plus a detailed physical map of the state, write me at the New York State Department of Commerce, Room 866, 112 State Street, Albany 7, New York.

Ronald B. Peterson

*Director, Industrial Location Service*

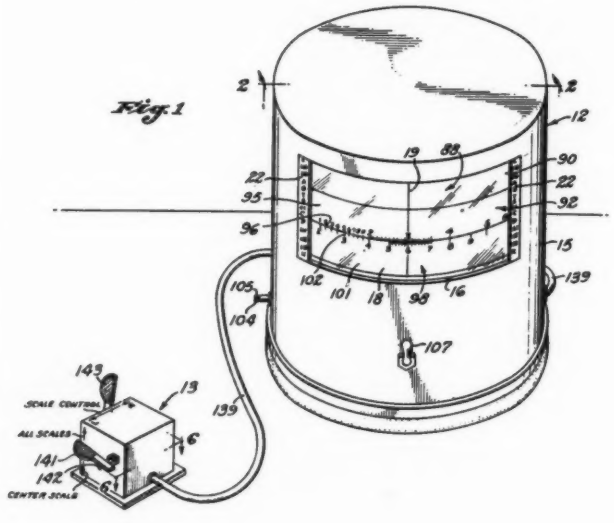
## Genius at Work

*From the patent collection of Mike Rivise*

Sept. 1, 1953 P. J. TOIEN 2,650,762

SLIDE RULE

Filed April 9, 1951 3 Sheets-Sheet 1



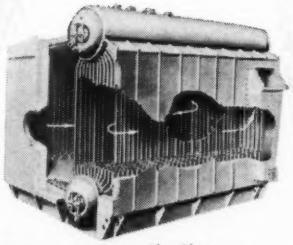

PAUL J. TOIEN, of Los Angeles, California, holds U. S. Patent 2,650,762, issued in September 1953. This patent is for a Slide Rule, and an interesting slide rule it is.

Conventional slide rules, Toien points out, require the use of both hands, ". . . so that it is not possible to simultaneously make and write down the calculations . . ." This slide rule overcomes this handicap. It can be operated with one hand, and perhaps *in extremis,* with only one finger. Then, with his other hand (we must assume that he has two hands) the user can write down his calculations.

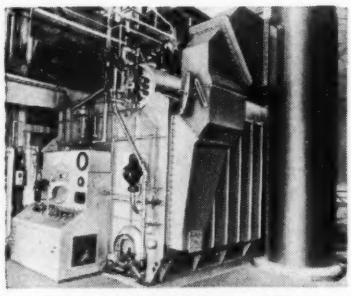
This invention offers a new way of life to one armed engineers with abacuphobia (fear of conventional calculating machines). There are disadvantages, as with all inventions. This slide rule is rather more complicated than most, for it incorporates a motor, clutches, brakes, a fairly complicated electrical wiring system, and quite a few ball bearings. As Toien sees it, this is only an apparent disadvantage. "One of the inherent disadvantages of the conventional slide rule," Toien says, "is the fact that such slide rules are not immediately available for use since they must be kept in the pocket or on the desk of the user and are frequently subject to being mislaid." There is no danger whatsoever of any engineer mislaying this slide rule, even in Grand Central.

# now... Combustion's VP Boiler with a

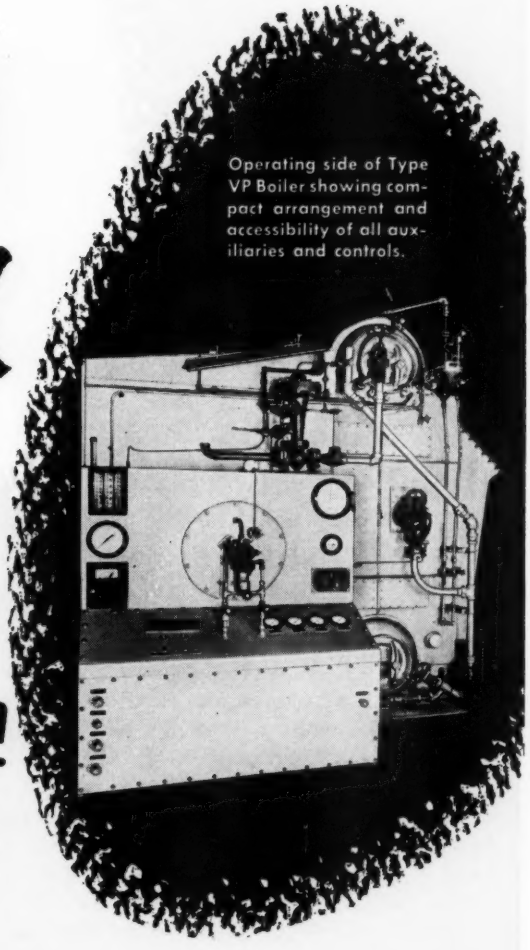
# NEW LOOK



Cutaway view showing arrangement of two-pass VP Boiler.



Industrial installation of VP Boiler in the South. Capacity — 33,000 lb steam per hr; design pressure 250 psi.



Operating side of Type VP Boiler showing compact arrangement and accessibility of all auxiliaries and controls.

## gives you more steam per dollar!

***THE VP BOILER is available in capacities ranging from about 4,000 to 40,000 lbs of steam per hr, and pressures up to 500 psi.***

Combustion's well-known C-E Package Boiler, Type VP, has a *new look* . . . outside and inside!

**Outside.** The VP's exterior is more streamlined, more compact. The controls and fan are now an integral part of the boiler front. Duct work is simplified. This means better appearance, easier maintenance, better operation.

**Inside.** Now instead of 2" diameter tubes you'll find 2½" tubes swaged down to 2" at the drums — in all sizes above 15,000 lb per hr capacity. This permits closer spacing of the tube surfaces in the main boiler bank and results in up to 25 per cent more heating surface per tube. It increases mass flow rates, assuring more efficient heat transfer. All this adds to up more steam than from the former VP Boilers of the same size.

All of the existing *extra* features which contributed to the enthusiastic acceptance of the original VP design remain. Briefly summarized they are:

- **More water cooling** per unit of furnace volume than any other boiler of the VP's size and type.
- **Quiet centrifugal fan,** which operates at low speed and with an exceptionally low noise level.
- **Large lower drum,** which facilitates handling wide load swings . . . permits a simple, symmetrical tube arrangement . . . simplifies inspection.
- **Single Burner** assures balanced furnace conditions and air distribution . . . is easier to operate and to maintain . . . simple burner control equipment . . . no air leakage through idle burner . . . change oil gun, when required, in seconds.
- **Simple baffle arrangement,** which means maximum heat transfer rate . . . no dead gas pockets . . . simplified soot blowing.

The *New* VP Boiler not only looks more attractive but it is functionally improved and stands ready to deliver more steam per dollar.

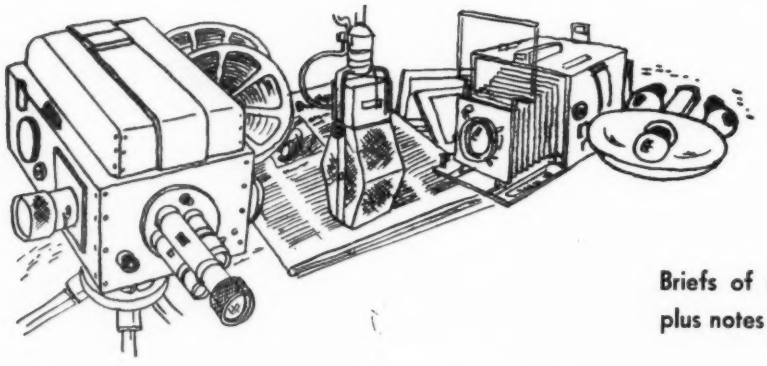
Write, today, for complete information. Ask for new catalog VP-256 (just off the press) which contains specifications and general information on dimensions, space requirements, construction details and controls.

## COMBUSTION ENGINEERING

**Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.**

**BOILERS, FUEL BURNING & RELATED EQUIPMENT; PULVERIZERS, AIR SEPARATORS & FLASH DRYING SYSTEMS; PRESSURE VESSELS; AUTOMATIC WATER HEATERS; SOIL PIPE**

B-812A



# NEWS

**Briefs of current interest to the consulting profession plus notes on new equipment in the field of engineering**

## Barge-Cast Concrete and Paper Tubes Speed Bridge Construction

Two major construction innovations are cutting time and cost in erection of the $3½ million Dauphin Island Bridge across Mississippi Sound from the Alabama shore. Reinforced concrete roadway slabs are precast in reusable steel forms specially constructed on barges so that the slabs set and cure en route to the bridge site. The second job-developed system for speeding up construction utilizes paper forms for encasing steel bearing pilings with concrete below and above the water line.

Development of the barge-mounted forms into which truck-mixed concrete is poured 27 mi from the bridge site was worked out by the joint contractors, Blount Brothers Construction Co. and Kansas City Bridge Co., and Irvington Form & Tank Co. who built the ten gage sheet-steel forms. Precasting onto the barges eliminates the problems of setting up a casting yard and casting in forms on shore, rehandling slabs onto barges for delivery to the site, and eliminates hazards of pouring in place in an open stretch of Gulf waters subjected to sudden and severe blows and storms.

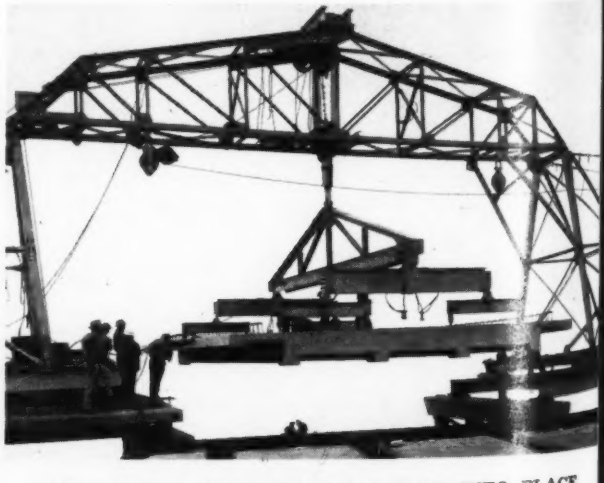
Steel reinforcing for the precast roadway slabs is tied into cages in special false forms on the bank of the Mobile River. The entire cage for one slab is lifted from the false form and lowered into place on the barges by a Bucyrus 38 B crane. The barges are then towed to Radcliffe Gravel Company's water front plant on the Mobile River where the concrete is poured. Three of the 29 x 34 ft slabs are poured on each of six barges, 85½ yd to the barge. Slabs are screeded and belted and cured with Hunt Process clear curing compound.

Concrete mix, developed by Joe Hester of the Alabama Highway Dept., calls for 541 lb cement, 135 lb fly ash, 3 percent entrained air, 38.9 gal water, 1094 lb sand, and 1728 lb gravel per cu yd. Use of locally produced fly ash as a cement replacement produces considerable savings in construction cost and provides a sea-water-resistant concrete.

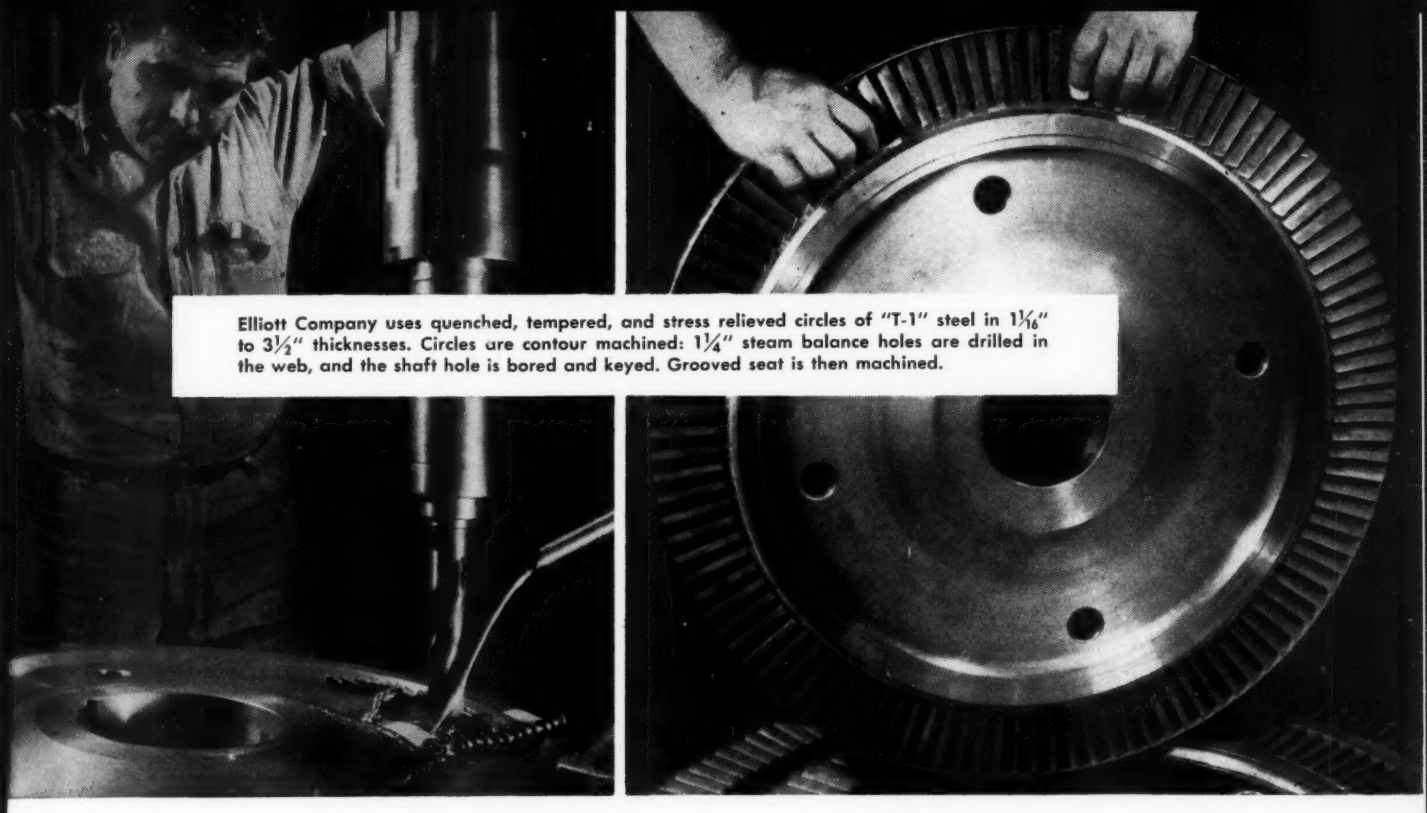
At the bridge site a slab-placing traveler, designed especially for the project and equipped with a Skagit model G-70 hoist, travels on its own tracks as the bridge grows, reaches down between pile bents and connects its lifting beams to eight lifting eyes screwed into coil anchors cast into the slab. Before the hoist takes the load, air pressure is applied through large diameter hoses placed under the soffits to break the bond and pop the slabs loose from the forms.

The hoist lifts the slab above the level of the roadway, revolves it through 90 degrees, and lowers it into place on the concrete caps. In this way it is possible to get barges between the bents which are 34 ft apart. Average time for lifting and setting a slab in place is 50 to 55 min., including drilling holes and placing dowel pins into the caps on the

CONCRETE IS POURED INTO 20 IN. DIA PAPER TUBE TO ENCASE PILING ABOVE AND BELOW WATER LINE.



HOIST LIFTS 65-TON ROADWAY SLAB INTO PLACE ON 23 FT CONCRETE CAPS, 3 FT WIDE AT TOP.



Elliott Company uses quenched, tempered, and stress relieved circles of "T-1" steel in 1 1/16" to 3 1/2" thicknesses. Circles are contour machined: 1 1/4" steam balance holes are drilled in the web, and the shaft hole is bored and keyed. Grooved seat is then machined.

# *New* USS "T-1" Steel cuts material cost 60% in rotor discs of small turbines

## *Provides high strength at high temperature, and stability at high speed of rotation*

• The Elliott Company, Jeannette, Pennsylvania, makes industrial steam turbines for driving pumps, fans, blowers, and other rotating equipment. The steel for the turbine discs must withstand high stresses at high temperatures and at speeds as high as 6,000 rpm. It must be sound throughout. That's why Elliott Company has switched to new USS "T-1" Steel in these discs.

"T-1" provides a minimum yield strength of 90,000 psi. and good creep rupture strength to 900°F. It poses no severe fabrication problems. What's more, "T-1" costs 60% less in this turbine application than the alloy steel previously used. And the switch to "T-1" required no change in design.

Although USS "T-1" Steel is comparatively new, it already has proved well suited to a great variety of applications. In addition to great high-temperature strength, it has extraordinary toughness at temperatures far below zero. It has excellent resistance to impact abuse, impact abrasion, and atmospheric corrosion. By taking advantage of these superior properties, you can reduce the size and weight, increase the strength and durability, and reduce the cost of such varied equipment as pressure vessels, power shovels, draft lines, storage tanks, conveyors, bridges, and towers. Where field fabrication or repairs are necessary or desirable, "T-1" cuts costs still further because it can be welded or flame cut either in shop or field without pre-heating or stress relieving.

Send the coupon for complete information.

United States Steel, Room 4635
525 William Penn Place
Pittsburgh 30, Pa.

☐ Please send me your booklet, "United States Steel presents T-1" which contains the full story of "T-1" steel.

☐ Have your representative get in touch with me.

Name.....

Address.....

City.....State.....

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UNITED STATES STEEL EXPORT COMPANY, NEW YORK

## USS "T-1" CONSTRUCTIONAL ALLOY STEEL

USS

**SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.**

UNITED STATES STEEL

fixed end of each slab. Curbs are poured after slabs are placed.

Secret of the piling encasement procedure is a job-developed air and water jetting device which permits seating each concrete encasement two feet below the ground line which varies from one foot to sixteen ft below the water line. Development of the device made it more efficient and economical to use the 20 in. diameter circular encasements than the standard 16 in. square encasements.

Each paper form, or Sonotube, is fitted with a wooden bottom shaped to fit the H-shaped piling. The form is then set in the jetting cage which extends two feet below the bottom of the tube and which has six jets. Ground line is sounded and the jetting cage, Sonotube, and reinforcing spiral slipped over the upper end of the piling.

Encasement concrete pouring begins with the bottom of the Sonotube just above the water line and weight of additional concrete carries the device to the bottom as pouring continues, so that all concrete is placed in the dry. A mandrel trips the jetting cage as it reaches the ground line. When the full encasement has been poured, it is topped off one foot above water line and jetting cage recovered.

Sway braces make it more efficient to pour the remaining part of the encasing concrete as a second operation since the Sonotubes must be slit and notched to fit these braces.

Another advantage of the paper forms is that they eliminate external curing and keep fresh concrete from exposure to sea water.

The project also includes a 210 ft lift span with a vertical clearance of 85 ft. The structural steel lift span towers will rest on steel caissons filled with concrete and conventional bridge piers.

Communication on the project is maintained through use of a Motorola radio network connecting tugs, major operations, office, and superintendent. Portable sets are used for isolated operations.

The bridge, designed by John W. Chambers, chief bridge design engineer of the Alabama Highway Dept., will connect the southernmost end of Alabama State Highway 163 at Cedar Point with Dauphin Island which lies between the Gulf of Mexico and Mississippi Sound. Dauphin Island is being developed, under sponsorship of the Mobile Chamber of Commerce, as a resort area.

## Carport Relieves Parking Problems

Where Chicago has gone underground to solve its downtown parking problem, Oklahoma City, Okla. has built upwards.

The four-level building, designed to take 657

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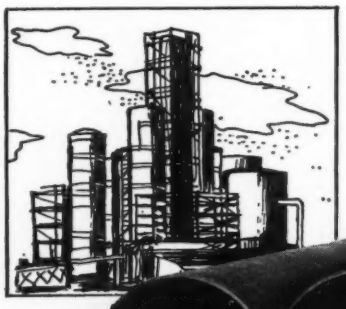
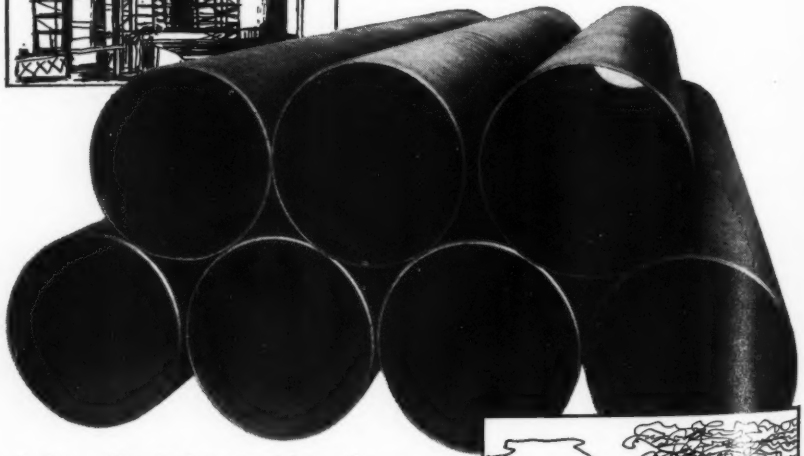
For Large O. D.
Alloy Steel
PIPE

*For Specialized Uses*
*In Oil Refineries*
*And Power Stations*

You can depend on Posey to meet your requirements in large O. D. alloy steel pipe . . . and you can depend on Posey to turn out your job economically and on time.





● *Posey specializes in large O. D. Pipe and Pilings of low and high alloy steel, alloy clad steel, carbon steel, and wrought iron.*

● *Posey Alloy Steel Pipe is fabricated in accordance with ASTM specifications, Class A 155-52 aT.*

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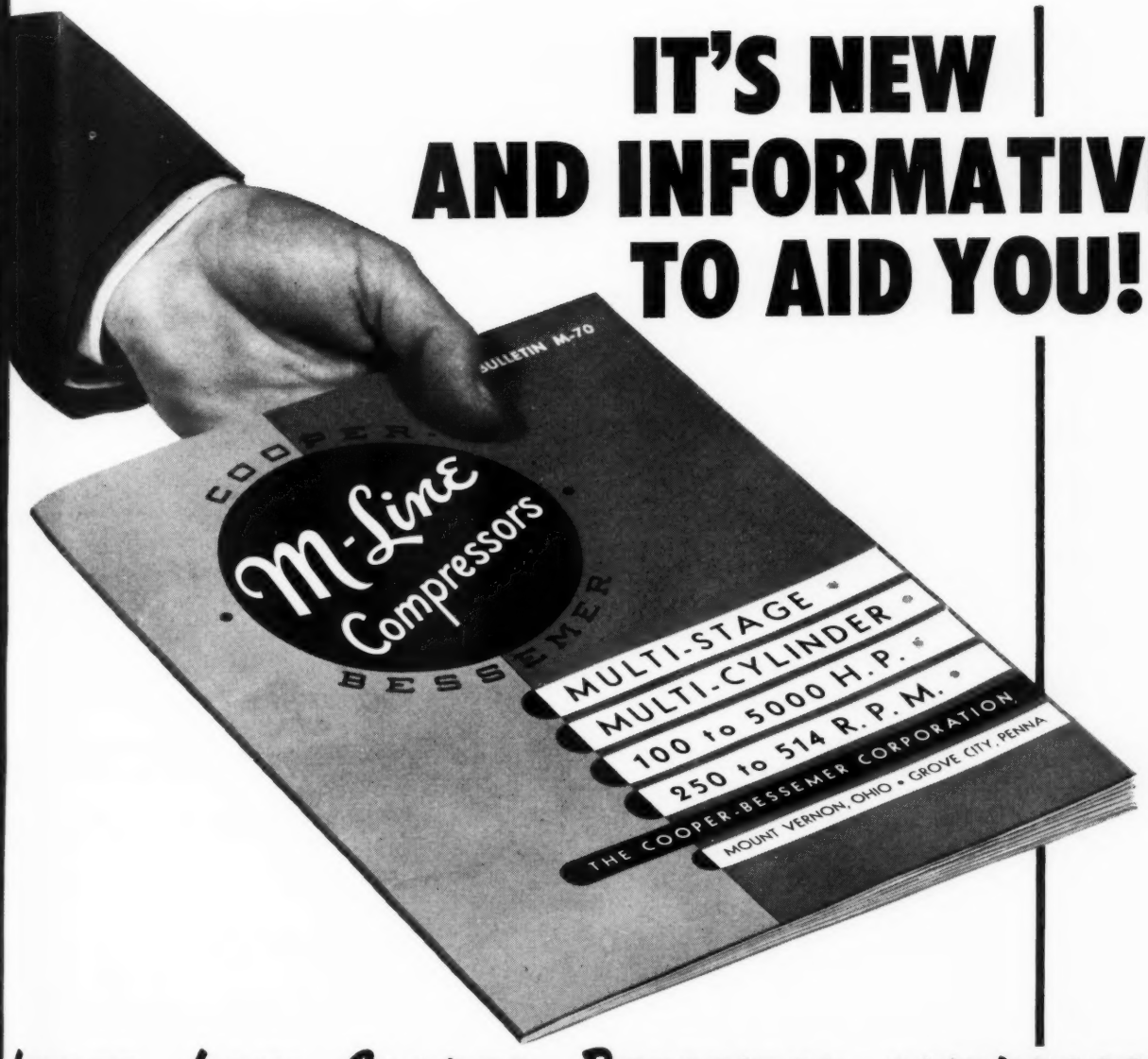


## learn how Cooper-Bessemer compressors can cut your costs!

THE new Cooper-Bessemer M-Line Bulletin offers you complete information on economically meeting compressor requirements from 100 to 5000 horsepower. This interesting 44-page booklet simply and fully explains how and why Cooper-Bessemer compressors assure you maximum trouble-free performance at minimum operating expense.

Additional bulletin features include complete data on design, lubrication, automatic controls, cylinders, motor and drives, specifications and photographs of various compressor installations.

Cooper-Bessemers offer you new, unusual plus features that are paying off in job after job. To find out about them, send for your M-Line Bulletin today.

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THE COOPER-BESSEMER CORPORATION 14
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## Carport for Public Parking

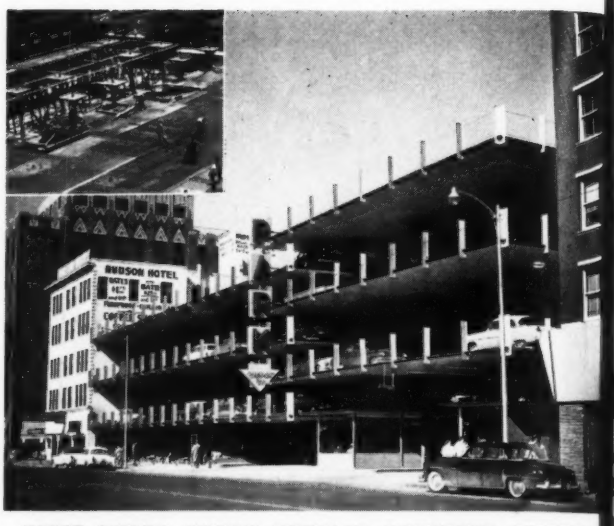
—*Starts on page 68*

cars, may set a pattern for future buildings where space is limited and construction time and cost must be held to a minimum.

Use of precast reinforced concrete columns permitted the contractor to begin erection the same day that the lot was vacated. These columns support four-way reinforced concrete slabs. The architects, Bailey, Bozalis and Associates, designed circular ramps of reinforced concrete to carry cars from ground floor to first upper deck. Straight ramps cantilever from each of the smaller decks up or down to each of the overlapping larger decks.

The precast columns consist of 6-½ in. dia steel pipe core reinforced with Steelcrete Expanded Metal which is welded to the core. Steelcrete of various weights, sizes, and cross-sectional area, manufactured by Wheeling Corrugating Co., Wheeling, W. Va., was also used to reinforce slabs and ramps since it could follow contour of the form work without the need of shop or field bending equipment. A crew of eight men was able to lay steel on a 45,000 sq ft deck in six working days.

The open-deck garage, with 180,000 sq ft of parking space and 8000 sq ft of shop space on the ground floor, was built for approximately $600,000. This is about $800 per parking space as compared with a cost of $1800 per space in conventional construction. Mendel Glickman was structural engineer and Harmon Construction Co. was general contractor.

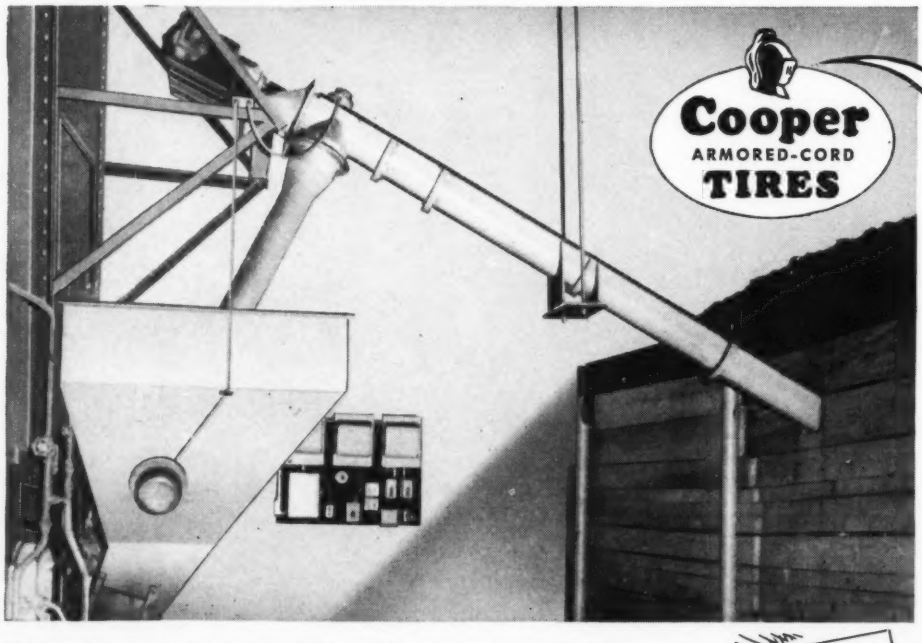



INSET PHOTO SHOWS PRECAST CONCRETE COLUMNS IN PLACE TO SUPPORT NEXT CANTILEVERED LEVEL.

## Handling System Used to Store and Process Phosphate Rock

To increase the tonnage of materials handled through the Port of Lake Charles, Louisiana, and


**SWITCHING TO AUTOMATIC COAL HANDLING, COOPER TIRE AND RUBBER**




**"TAKES IT UP A FLO-TUBE"**

. . . We are very pleased with the FLO-TUBE operation. To date we have put some 10,000 tons of coal through it without maintenance.

Very truly yours,
COOPER TIRE & RUBBER COMPANY
Mil McKinley, Chief Engineer

This shows how easily CANTON'S FLO-TUBE can be adapted to existing coal fired equipment. Available in Heavy Cast Iron U-Trough design for permanence, or Steel U-Trough or Round Pipe types for economy. Direct Drive through Geared Motor reduces H.P. required and operating costs—also assures dependability and low upkeep. Also can be had in completely dustproof "package-unit" type combined with Canton Ramfeed and Screwfeed Stokers.

Exposed end placed in Coal Bin picks up coal and fills Hoppers automatically. Can be applied on incline or horizontally to feed one or a series of Hoppers. Bin Level Controls keep Hoppers filled to desired height at all times. Alarms or Lights can be applied to signal fuel supply failure. U-Trough design permits instant accessibility to all parts.

WRITE FOR THIS BROCHURE

CANTON STOKERS

**CANTON STOKER CORPORATION**
SPECIALISTS IN AUTOMATIC COAL FIRING, HANDLING AND CONTROL EQUIPMENT
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CANTON STOKER REPRESENTATIVES IN ALL PRINCIPAL CITIES WILL BE HAPPY TO GIVE YOU COMPLETE INFORMATION AND PRICES . . . OR WRITE DIRECT

# "PACKAGED" FANS

## Clarage V-belt Ready Units answer economically your smaller air handling requirements

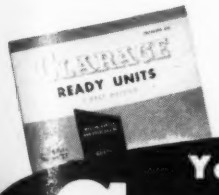
**omplete** Ready to run, with fan, motor, and drive in one compact, easily stalled assembly. 18 sizes, wheel diameters 9¾ to 24½", capacities to 12,000 cfm. Direct connected units lso available.

**daptable** Quickly adjustable in the field for various directions of air discharge. Slow speed, forward curved blade wheels or medium speed, backwardly inclined blade wheels available. Special units for handling corrosive gases and other special assignments can be provided.

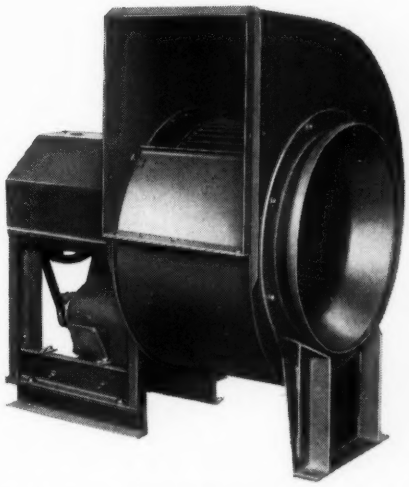
**rugged** Typical Clarage heavy-duty construction throughout. All working parts readily accessible, yet entire drive (except on largest sizes) is within frame of unit — an important distinguishing feature!

**quiet** When properly selected and applied, Clarage Ready Units meet the most exacting requirements in respect to quietness of operation.

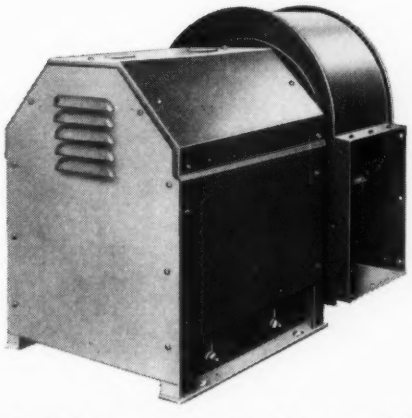
**capable** Within their performance range, these units are unsurpassed for maximum air delivery at low power cost. You can select them with confidence for ventilation, exhausting, and other low pressure applications.




**For 28 pages of complete information on Clarage Ready Units, request Catalog 515.**



View of a standard Ready Unit as built in all but the three largest sizes. Note how operating parts are shielded.



Ready Unit equipped with drive guard (at the end) and outdoor covers (on the sides) which provide complete weather protection.

**CLARAGE FAN CO., Kalamazoo, Mich.**

**You can Rely on CLARAGE**

***. . . dependable equipment for making air your servant***

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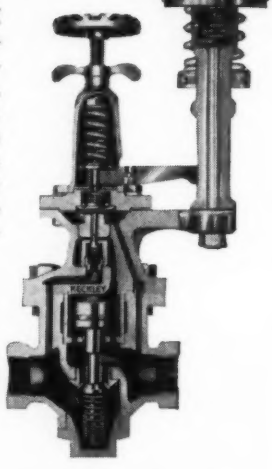
## FINER TEMPERATURE CONTROL THAN EVER BEFORE POSSIBLE

The Keckley Type PTM Modulating Pressure-Temperature Regulator controls temperatures in batch processing, air ducts and other control jobs with an exactness that has never before been possible. As temperature tends to vary, the thermostatic control unit acts upon the pressure regulator to reduce or increase steam pressure. Pressure will modulate smoothly and rapidly between initial setting and zero, thereby preventing overrun. Rate of pressure modulation is adjustable.



*Send for Catalog 54-1 — describes the complete Keckley line of Steam and Liquid Control Equipment.*

***Standard, interchangeable body and parts. Stainless steel Unit Pilot Valve, Main Valve and Seat.***

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Pressure Regulators • Temperature Regulators • Float Valves • Strainers
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**NICKEL PLATE ROAD**
**1405 Terminal Tower, Cleveland 1, O.**
**Phone: MAin 1-9000**

NICKEL PLATE ROAD


**Handling System Stores Rock**

*— Starts on page 70*

to provide farmers in southeastern states with low-cost fertilizer, the Lake Charles Harbor and Terminal District has put into operation storage and processing facilities for phosphate rock at Westlake Terminal. Secondary usage of the system will be for storing and processing barytic ore.

The phosphate rock, brought in by barge from Florida where it is mined, is loaded in concrete silos by conveyor belts. The rock is taken from the silos as needed, crushed, and loaded in railroad cars for shipment to fertilizer plants.

Since the building site is on low ground and only 350 ft from the water's edge, it was necessary to support each of the eight, 30 ft in dia by 70 ft high silos on 80 ft deep concrete piling supports. After erection, a finishing coat of a silicone compound was applied to the silos to eliminate water seepage and retard weathering and spalling.

According to E. J. Christman, Port Director, this is the only installation of its kind where phosphate rock is being transported, stored, and processed in this manner. The facility was designed by F. Shutts' Sons, engineering consultants for the Port of Lake Charles. Storage silos were supplied and erected by The Marietta Concrete Corp. and Hewitt-Robins furnished the conveyors. ▲▲


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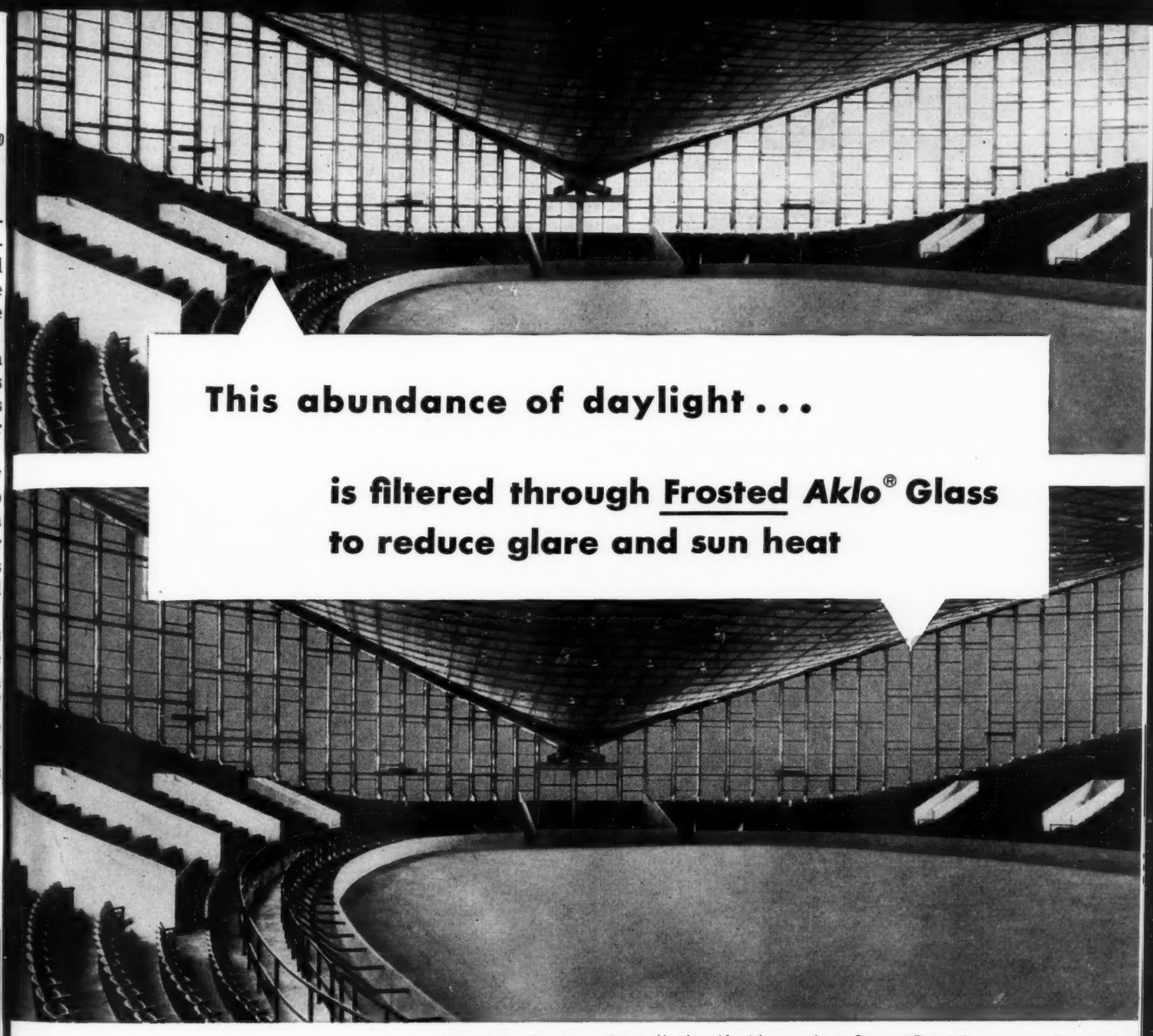
# MIAMI BEACH



# This abundance of daylight . . .

## is filtered through Frosted *Aklo*® Glass to reduce glare and sun heat

Wm. Henley Deitrick, architect; Matthew Nowicki, consultant; Severud-Elstad-Krueger, consulting enginee

This is one of America's outstanding buildings . . . the prize-winning North Carolina State Fair Arena. In it, the architects and engineers employed two design features that produce eye-comfort daylighting:

1. A large expanse of glass that eliminates the glaring effect of contrasting opaque walls and "hole-in-wall" windows.
2. A filter of blue-green Frosted *Aklo* Glass.

Frosted *Aklo* Glass softens and diffuses direct sunlight, sky brightness and dazzling reflections. It cuts down sun heat. Used in ¼" thickness, it shuts out as much as 44% of the sun's radiant energy. And it's a restful color . . . a "cool" color.

*Aklo* is widely used in factories, offices and many othe buildings. Better selling, greater comfort for occupants . . better workmanship . . . better employe relations are a worth-while benefits.

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A call will bring a rad ometer demonstration kit t your desk. It shows you ho *Aklo* Glass reduces glare an sun heat. Call your L·O· Glass Distributor or Dealer listed under "Glass" in the yello pages of your phone book. Or write to Libbey·Owens·For Glass Company, 608 Madison Avenue, Toledo 3, Ohio.

**AKLO GLASS** **FILTERS DAYLIGH**

*made by Blue Ridge Glass Corp.*
*sold by Libbey-Owens-Ford Glass Distributors*

# MEN IN ENGINEERING

★ Dr. G. Albert Hill joins the firm of Frank L. Ehasz and Associates, as senior consultant and research associate on highway matters.

★ Arthur D. Little, Inc. announces that Dr. Benjamin S. Mesick has joined the firm as a senior staff member. His chief responsibilities will be to expand the company's activities in titanium fabrication.

★ Michael Baker, Jr., Inc. has been authorized by the Kingdom of Jordan to complete the first phase of a $100 million master plan for developing that Middle Eastern nation. The Harza Engineering Co. is associated with Baker in the project.

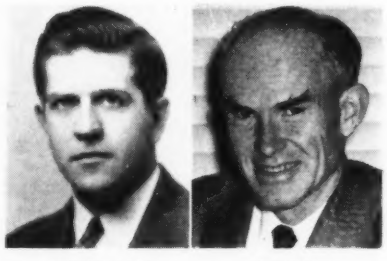
★ Three organizations are pooling facilities to form International Resources Engineering and Exploration Group (IREX). Members of the group are Brown & Blauvelt, consulting engineers; Jack Amman Photogrammetric Engineers; and Geophoto Services, consulting geologists. Formation of IREX does not represent a merger but coordinates the related facilities of the three companies to provide an integrated service in all phases of natural resource studies.

★ Howard E. Murphy, PE, has announced that his organization will undertake design and construction supervision. The organization is unusual in that it is an association made up of engineers who have reached retirement age and most of whom have been associated with Stone & Webster Engineering Corp. Organized in 1954, the original and still the principal objective of the organization is to provide seasoned and competent source of engineering service to clients who require such talent for relatively short times. Besides Murphy, the principal associate is S. P. Melville.

★ As a result of expanded activities, the New York architectural firm of La Pierre, Litchfield & Partners has moved to larger offices at 292 Madison Ave., New York City.

★ At Stone & Webster Engineering Corp., Fred W. Argue was elected a vice president. Leonard B. Buchanan of S&W Service Corp. was honored on his 82nd birthday with a dinner at the Algonquin Club, attended by a group of executives of S&W, Inc., and affiliated companies.

★ Philip M. Grennan, formerly of Ford, Bacon & Davis, has joined the office of Alfred Easton Poor, Architects as an associate.



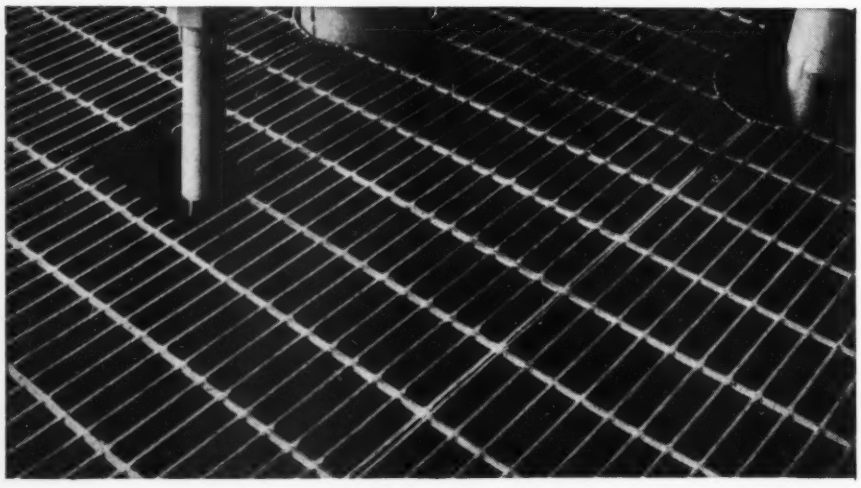
GRENNAN WRIGHT

★ William T. Wright, civil and structural engineer and member of the architectural-engineering firm of Kistner, Wright and Wright, of Los Angeles, has been reappointed to the State Board of Registration for Civil and Professional Engineers of the State of California.

★ Nuclear Development Associates, Inc., of White Plains, has purchased an 1100-acre tract of land in Dutchess County to serve as a scientific laboratory.

★ Martin P. Korn, formerly consulting engineer with Giffels & Vallet, Inc., has moved to Boca Raton, Fla. where he will continue in private practice, lecturing and writing on a limited scale.

★ Officers of the Cooling Tower Institute for 1955 are: president, Neal B. LauBach, Cooling Equipment Dept., Hudson Engineering Corp.;

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**Tailor Made to Your Specs**

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**FREE SAMPLE**
We'll send this handy paper weight if you request it on your company stationery.

**Standard Steel Spring Division**
ROCKWELL SPRING AND AXLE CO.
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If you have clients who are bothered by dusty conditions in their plant operations, the fastest and easiest way to solve your problem is to call on Johnson-March dust control engineers.

No matter what size or type of plant . . . what type of material is involved . . . or in what operation the dust occurs, Johnson-March has the experience necessary to recommend an effective liquid or dry system to stop dust at lowest possible cost.

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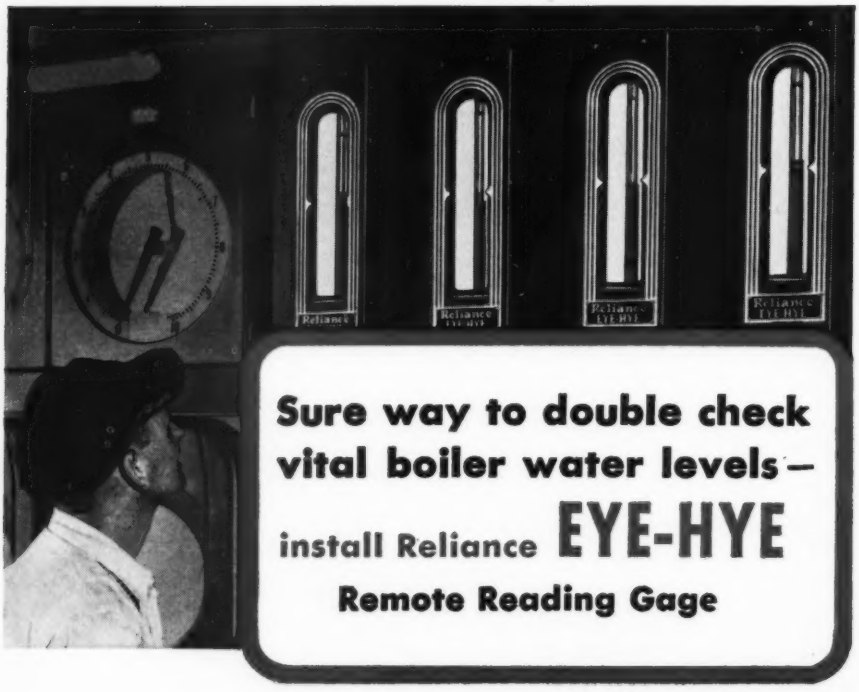
CANADIAN REPRESENTATIVES: G. F. Sterne & Sons, Ltd., Brantford, Ontario



**Sure way to double check vital boiler water levels—**

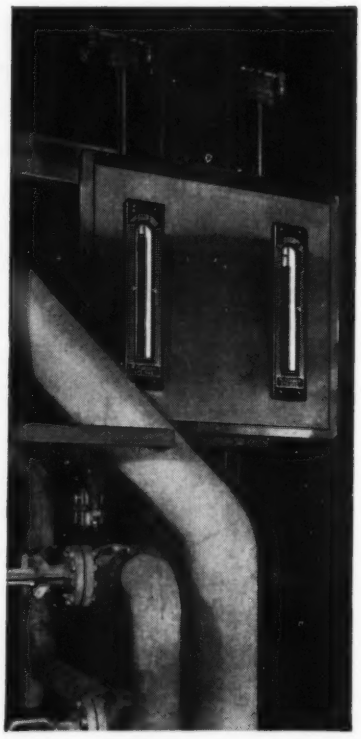
**install Reliance EYE-HYE**

**Remote Reading Gage**

It's fine to have automatic controls, but be sure you have the important safeguards against possible failure — adequate *maintenance* and *cross-checks.*

EYE-HYE is your reliable cross-check for *boiler water levels.* A manometric-type remote reading gage, it keeps operators informed on water level status. Easier to read than conventional gages, although it's the same familiar form — a vertical column of liquid. EYE-HYE's indicating fluid is a pleasing green that "pops out", brightly illuminated from the rear.

You can place EYE-HYE any reasonable distance from the drum — above or below it, on wall or instrument panel. Easy to install and maintain — no mechanical working parts — no adjustments on location. Write for Bulletin CO and learn how EYE-HYE can increase the efficiency of *all* your water levels.



*How one user checks water levels in surge tank and feed water heater with long type EYE-HYEs. (Face plate can be calibrated at factory.)*

**The Reliance Gauge Column Company**

***5902 Carnegie Avenue • Cleveland 3, Ohio***

## MEN

*—Starts on page 74*

vice president, Paul R. Hoffmann, Lilie-Hoffmann Cooling Towers, Inc.; secretary, Clayton E. Pickup, Fluor Corp., Ltd.; and treasurer, Sidney Levine, Sante Fe Tank & Tower Co.

★ Design offices of Whitman, Requardt & Associates have been consolidated on the fourth and fifth floors of the Loyola-Federal Building, 2 W. Preston St., Baltimore 1, Md. Executive offices remain at 1304 St. Paul St., Baltimore 2. The firm formerly had offices at four different locations.

★ Walter J. Barrett, electrical coordination engineer at New Jersey Bell Telephone Co., becomes president of the United Engineering Trustees, Inc. He represents AIEE on the Board of Trustees and is treasurer and director of AIEE. He is also a director of the Engineers Joint Council.

★ U. S. Steel's American Bridge Div. announces appointment of J. D. Rollins to the position of vice president-engineering.

★ A new design, engineering, and construction organization, The Poole-Pritchard Co., Ltd., has been formed with offices in Edmonton, Alberta, Canada. Area of operations will be in western Canada from the Great Lakes to the Pacific. The organization is a combination of the Poole Construction Co., Ltd., of Edmonton and J. F. Pritchard & Co., of Kansas City, Mo.

★ The American Concrete Institute has elected Charles S. Whitney as president for 1955. Whitney is partner in the consulting engineering firm of Ammann and Whitney, New York and Milwaukee. Walter H. Price, head of the U. S. Bureau of Reclamation's engineering laboratories, Denver, was elected vice president for a two year term.

★ New officers of the American Society of Heating and Air-Conditioning Engineers are: president, John E. Haines, Minneapolis-Honeywell Regulator Co.; first vice president, John W. James, McDonnell & Miller, Inc.; second vice president, Peter B. Gordon, Wolff & Munier, Inc.; treasurer, Elmer R. Queer, Pennsylvania State University.

★ The Franklin Institute Laboratories for Research and Development have announced establishment of a new research section for heat and power. A major activity of this section will be research on problems inherent in design of atomic power plants. Francis L. Jackson will head the new section. ▲▲

# Delivery...ON TIME...

**A delay on this particular job meant valuable time lost . . . dollars wasted . . . Ric-Wil, not only prides itself in offering the finest in prefabricated insulated piping, but takes pride in ON TIME DELIVERY . . . and speaking of delivery . . . the best way to meet piping construction schedules is to contact your Ric-Wil representative early in the planning stage. He will be glad to help on scheduling delivery . . . and "lend a hand" on technical information as well.**

**New** Ric-Wil catalog is available . . . write for your copy . . . now.

*Quality Piping Systems . . .*
*. . . of Exceptionally High Thermal Efficiency*

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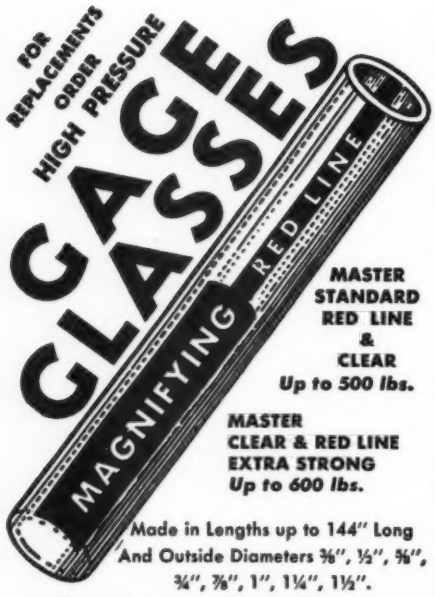
**PREFABRICATED INSULATED PIPING SYSTEMS**

**BARBERTON, OHIO**




MASTER STANDARD RED LINE & CLEAR *Up to 500 lbs.*

MASTER CLEAR & RED LINE EXTRA STRONG *Up to 600 lbs.*

Made in Lengths up to 144" Long And Outside Diameters ⅜", ½", ⅝", ¾", ⅞", 1", 1¼", 1½".

**High Pressure Composition**

**ERNST RUBBER GASKETS**

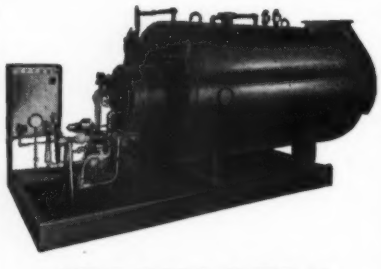
*All sizes to fit your gages and valves*

FIG. 21—Lip Mold

FIG. 22—Standard

**ERNST WATER COLUMN & GAGE CO.**

Send for Catalog LIVINGSTON, N. J.



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60 to 600 Horsepower. High and Low pressure. A.S.M.E. Code and Nat'l Board.

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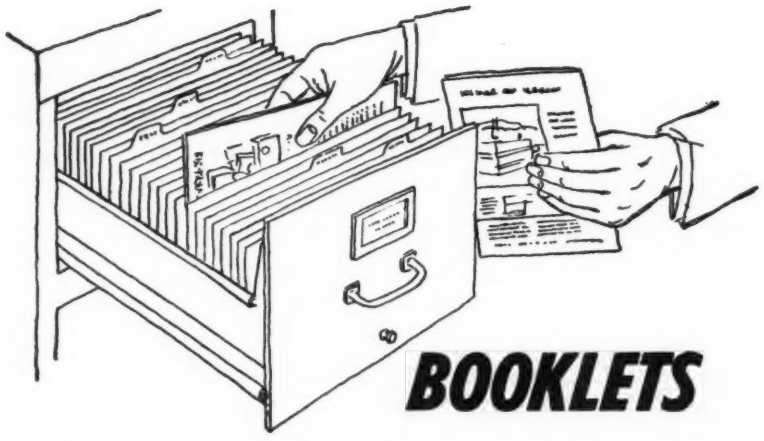


# BOOKLETS

Personal copies of booklets can be obtained by writing directly to the manufacturers

"THE CURTAIN WALL STORY," 20-page bulletin, covers the new techniques and improved equipment being used to field-assemble insulated metal curtain and sandwich walls at substantial savings in cost. *Nelson Stud Welding Div., Dept. CE, Gregory Industries, Inc., Lorain, Ohio.*

FLOTATION UNIT — Four-page bulletin WC-119 discusses the principles behind the design of the Aeroflotor, a new flotation unit for clarification, water recovery, product recovery, and pollution elimination. *Graver Water Conditioning Co., Dept. CE, 216 W. Fourteenth St., New York 11, N. Y.*

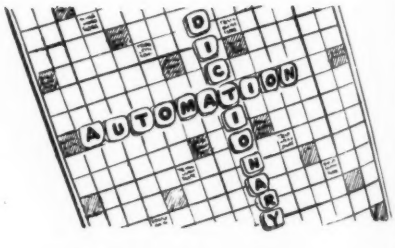
"WHAT YOU SHOULD KNOW ABOUT MODERN STEAM HEATING," 16-page booklet, is a "refresher course" in the use and specification of steam for heating. It outlines types of buildings, equipment, and heating requirements served most economically and efficiently by steam and provides a check list guide to follow in specifying such a heating system. *Steam Heating Manufacturers Association, Dept. CE, 450 East Ohio St., Chicago 11, Ill.*

"TIMBER FABRICATION AND ASSEMBLY WITH TECO CONNECTORS," 10-page bulletin 40M, describes and illustrates the two basic methods of timber truss fabrication — preassembly and prefabrication. *Timber Engineering Co., Dept. CE, 1319 Eighteenth St., N. W., Washington 6, D. C.*

LAMP DATA, diagrams, and illustrations on transformers for both multiple and series circuits for mercury lamp street lighting is contained in 16-page bulletin 551-5. Technical information will help you design a system with fewer lamps, fewer fixtures, more lumens per watt, and less maintenance. *Jefferson Electric Co., Dept. CE, Bellwood, Ill.*

TO HELP ENGINEERS specify the correct hydrant for every type of installation, 16-page catalog 54-5 describes in detail four types of hydrants including wall installations, post and box type, and encased types. Roughing-in dimensional data, recommended specifications, and engineering drawing are included. *J. A. Zurn Mfg. Co., Dept. CE, Erie, Pa.*

"DATA ON VERMICULITE CONCRETE PANEL OR SPANDREL WALLS," 68-page technical kit, contains complete basic design data and working drawings by Severud-Elstad-Krueger with their design analysis and recommended connection details for steel frame or reinforced concrete buildings. The kit, comprised of several booklets and specification sheets, is boxed in a folder. *Vermiculite Institute, Dept. CE, 208 S. LaSalle St., Chicago 4, Ill.*

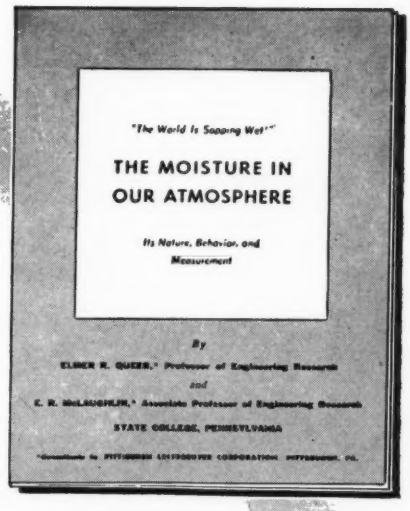



THIS "AUTOMATION DICTIONARY" covers some 87 words and phrases in the expanding vocabulary of automation. These are not standard engineering definitions but new engineering terms defined for general use. *Minneapolis-Honeywell Regulator Co., Industrial Div., Dept. CE, Philadelphia, Pa.*

SAND FILTER-CLARIFIER — Revised four-page bulletin 30-C describes operating principles and shows typical performance data and capacities of company's line of circular sand filter-clarifiers. *Hardinge Co., Inc., Dept. CE, 240 Arch St., York, Pa.*

CENTRIFUGAL PUMPS—The six steps outlined in eight-page manuel GR-155 will enable the designer to select centrifugal pumps for cooling tower

# If you're concerned about MOISTURE in air, gases or organic liquids...

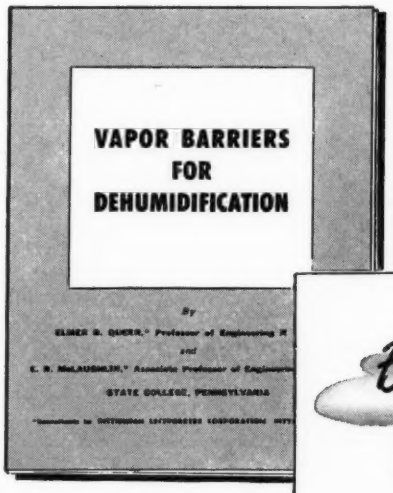



## SEND FOR THIS LITERATURE

Moisture you can't see or feel causes endless trouble. It creeps into materials and hinders their free flow, gums up machines and slows operations to a standstill. It upsets delicate chemical reactions, spoils products in process and storage. A Lectrodryer* booklet discusses *The Moisture in Our Atmosphere.*

The roadblocks you can set up against infiltration of moisture, the means you can employ to remove unwanted moisture and hold it down to desirable low limits—other Lectrodryer literature covers these subjects.

Lectrodryers are a complete family of machines for DRYing air, gases or organic liquids to low dewpoints. Whatever your specialty, you should have Lectrodryer data in your files for reference when moisture becomes a problem. This coupon will bring it to you.



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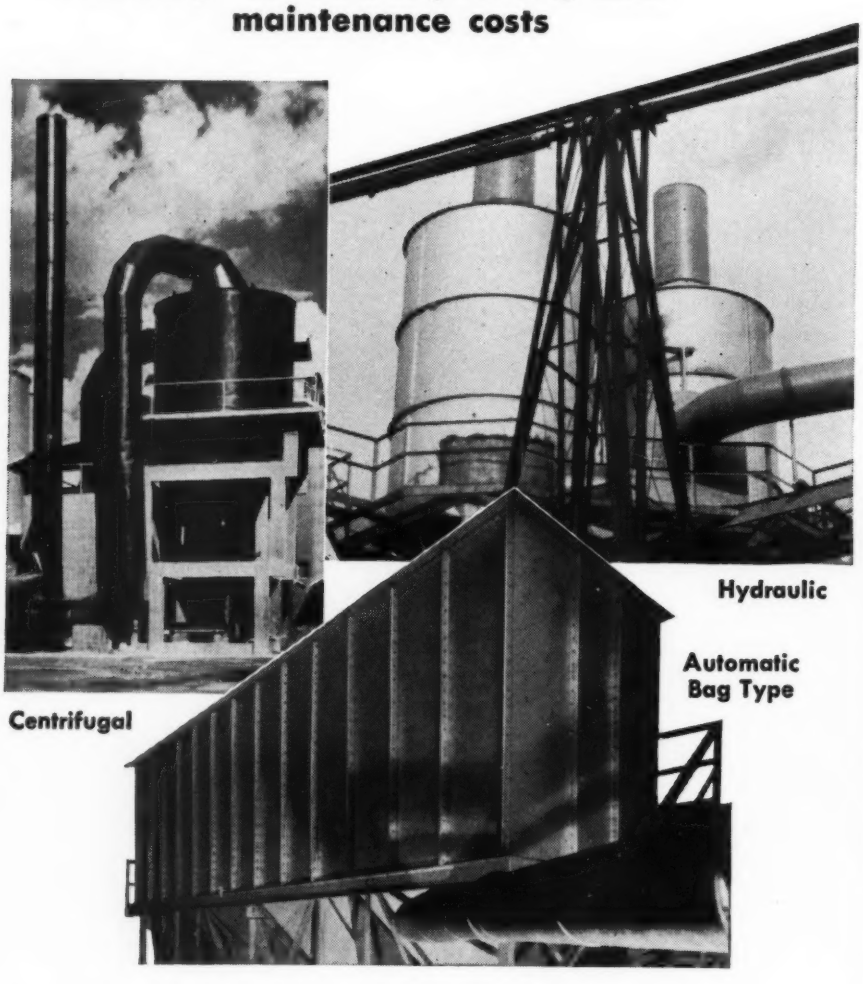
# Norblo

## Dust and Fume Collection Systems

**make outstanding records for high recovery with low operating and maintenance costs**



Hydraulic

Automatic Bag Type

Centrifugal

These three important types of Norblo collecting systems, frequently used in certain combinations, bring you economical, dependable control as required in a wide range of industries. "Guaranteed Efficiency" is not an empty phrase at Norblo. We stand back of every installation that's used for the purpose and at the capacity for which we designed it. All component parts are made by Norblo, under controlled specifications.

For more than 40 years Norblo has engineered and supplied installations of every size in the rock products, smelting, chemical, metal working, milling and processing fields. It pays you to get the facts about Norblo Dust and Fume Collecting Systems. Give us a description of your problems.

**The Northern Blower Company**

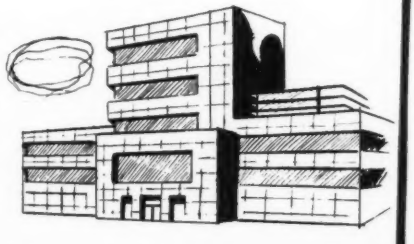
**Engineered Dust Collection Systems for All Industries**

**6426 Barberton Ave. OLympic 1-1300 Cleveland 2, Ohio**


## BOOKLETS —Starts on page 78

work that will assure proper circulation of the entire system. Included with the bulletin is a selection chart and list price sheet on Series 1522 and 1531 centrifugal pumps for cooling tower systems. *Bell & Gossett Co., Dept. CE, Morton Grove, Ill.*

"FOAMGLAS IN THIN WALL AND SANDWICH PANEL CONSTRUCTION," 11-page Booklet FB-102, explains what Foamglas is and how its special properties make it light-weight, easy to handle, strong, and an ideal insulation material. *Pittsburgh Corning Corp., Dept. CE, One Gateway Center, Pittsburgh 22, Pa.*



PORCELAIN ENAMEL PANELS—Flexibility of application and freedom of design choice in the use of porcelain enamel wall panels is pointed out in 11-page brochure. Architect's details show installation of Davidson Facia and Double-Wall panels in walls, sills, and copings in various types of construction. *Davidson Enamel Products, Inc., Dept. CE, 1109 Kibby St., Lima, Ohio.*

MERCURY STREET LIGHTING—Prepared as a practical reference for planning and procuring new street lighting systems, 35-page booklet B-6064 includes technical data on mercury lamps applicable to general lighting service, available luminaires, operating characteristics of systems, and a discussion of methods for economic evaluation of alternative lighting systems. *Westinghouse Electric Corp., Dept. CE, P.O.B. 2099, Pittsburgh 30, Pa.*

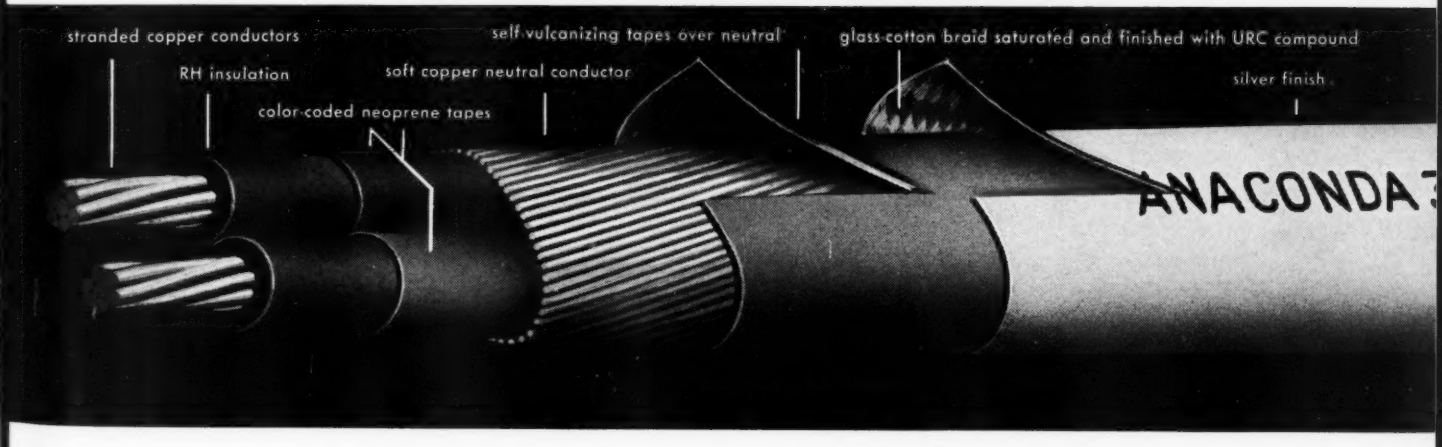
HOW THIS COMPANY SERVES the chemical, process, and petroleum industries is told in four-page folder. Photographs show storage tanks and process equipment now in use in various industries. *Graver Tank & Mfg. Co., Inc., Dept. CE, 332 S. Michigan Ave., Chicago 4, Ill.*

"ELECTRICAL OUTLETS WHEREVER YOU NEED THEM," 16-page booklet, gives complete details on F/C Duct Floors, standard reinforced concrete joist floors with a network of electrical distribution ducts buried in the structural slab. Technical specifications and details are included. *Concrete Reinforcing Steel Institute, Dept. CE, 38 S. Dearborn St., Chicago 3, Ill.*

## ANACONDA ANNOUNCES—NEW

# SILVALINE 100-AMP service entrance cable

**The *only* SE cable with URC† saturant and finish**




**This new Underwriters Type SE service entrance cable enables contractors to meet new NAHB Voluntary Adequate Wiring Code—to wire up for today's *and tomorrow's* load.**

The new Voluntary Adequate Wiring Code of the National Association of Home Builders calls for 100-amp service into the home.

Now, Anaconda introduces a new Type SE cable to help you take full advantage of this forward trend. It's Silvaline* 100-AMP cable – with actual capacity of 115-amps. Made with # 2 AWG copper – and Type RH insulation. And here are other advantages:

**Eliminates Complaints.** Silver finish on Silvaline takes any type or color of house paint . . . won't bleed through. Finish does not become sticky, won't flake or peel . . . will not mark walls. Flexible . . . clean and easy to handle.

**Direct to Range.** Silvaline can be installed from pole to house to meter in *one run* and then to range. No conduit is required. Fully approved. Saves time and money.

**Uninterrupted Service.** Silvaline is the only service entrance cable made with URC† saturant and finish. This weatherproof protection assures long life. There has never been a case of festooning or braid fraying with Silvaline.

Look for Silvaline 100-AMP at your Anaconda distributor. Available in sizes 3/c #2 AWG or 2/c #2 plus 1/c #4 AWG neutral. For informative bulletin on Silvaline and copy of new Adequate Wiring Code, write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y. 55331

*Reg. U. S. Pat. Off. †Utilities Research Commission

SILVALINE *service entrance cable*

ANACONDA®

*—Starts on page 48*

transformer is called upon to provide power for two substations. It may be necessary, therefore, to allow some reserve capacity in each transformer. Furthermore, the switching arrangements for this system are somewhat complex. A secondary selective system will generally cost 15 to 20 percent more than a corresponding radial system. Where long secondary ties are necessary, this may increase to the point where the secondary selective system becomes economically impractical.

### Secondary Network System

In the secondary network system, the secondaries of a group of substation transformers are connected together in parallel through a system of cables and tie circuit breakers. This system is further characterized by network protectors installed between the transformer secondaries and the substation secondary bus. Network protectors are circuit breakers having reverse power flow elements designed to open rapidly if the direction of power flow reverses.

The network system offers a near-maximum in service continuity. It provides secondary voltage stability under heavy loads applied to any substation secondary. Furthermore, load is diversified among the various substations. Smaller transformers can be used and still meet individual heavy demands for load. Maximum maintenance flexibility is achieved since any primary line, primary switch, transformer, or tie breaker can be taken out of service without interrupting the load. Major loads can be shifted from one section of the plant to another without relocation of substations.

Secondary network systems present a number of problems, however. Large short-circuit currents can be brought to bear on any point of the secondary system. This possibility calls for protection obtainable only from expensive secondary switchgear. Furthermore, a considerable amount of cable is generally required to connect substation secondaries, and a relatively large number of circuit breakers are required merely for interconnection. A secondary network system may cost as much as twice the price of a comparable radial system.

This system is also somewhat complex in its operation. The switching arrangements must be thoroughly understood before maintenance can be attempted. Transformer characteristics must match. Not only should transformers all be of very nearly the same capacity, but they also must have approximately the same impedance. If voltage taps are provided, all transformers must be tapped at the same voltage. Relatively large, wasteful circulating currents will result if these conditions are not met.

### Variations and Extensions

Many variations and extensions of these basic systems are possible—"spot secondary," "distributed secondary," "extended secondary," "looped," or "common secondary tie." It is possible to employ almost any primary system arrangement with almost any secondary system arrangement if basic electrical requirements of the load are met. The designer must decide which features of the systems are most significant for his specific needs, and design accordingly.

### Substation Size

It is possible to design a system using a large number of small substations, or a small number of large substations. The primary system is simpler and less expensive with a few large substations, but the secondary system is more complex and expensive. Most industrial applications seem to limit transformer size to between 500 kva and 1500 kva. For units smaller than 500 kva, the unit cost per kva becomes excessive. Over 1500 kva, the unit cost per kva does not decrease significantly. When these factors are combined with the cost of necessary feeder breakers, the substation total cost per kva may actually rise for units larger than 1500 kva. Exceptions sometime occur to justify larger unit substations, such as large spot loads. For general industrial application, however, these limitations have proven most economical.

### Secondary Distribution

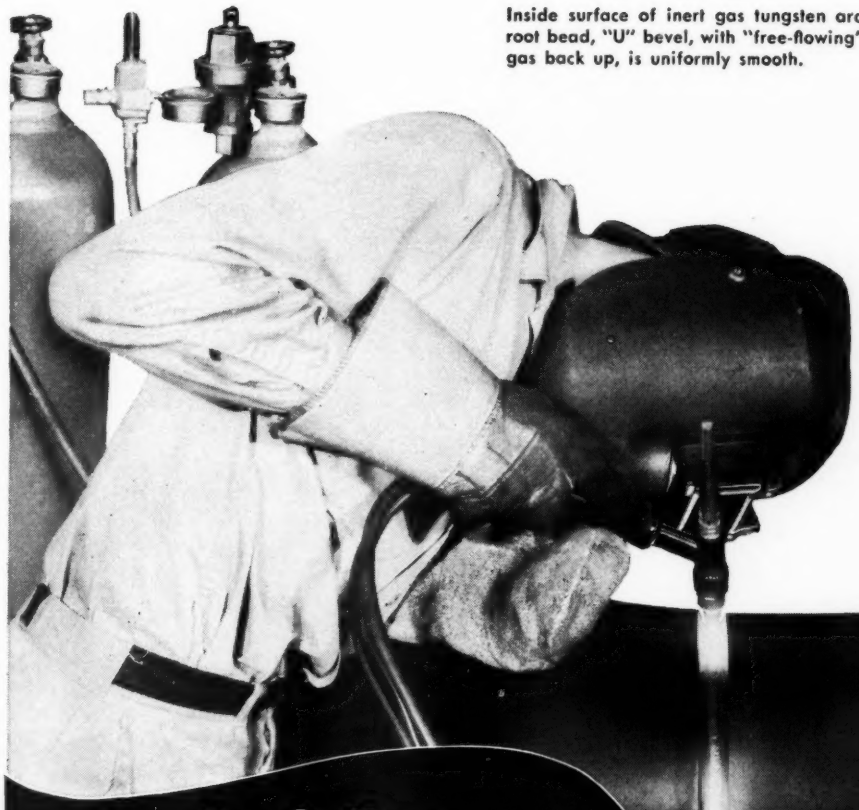
Secondary power must be made available to each load in the plant through a branch circuit. This can be accomplished through power distribution panel boards or by using plug-in bus duct.

Modern industrial electrical practice increasingly dictates the use of plug-in bus duct. A great advantage is offered in that power can be taken off at any point along the length of the run. Maximum flexibility also is achieved because circuits can be easily connected or disconnected.

Plug-in bus duct competes favorably with cable in installed cost-per-foot-per-ampere capacity where the load ranges in the order of 225 amperes or more. Cable with panel boards may be preferable for lesser loads or in the presence of unusual atmospheric conditions such as dirt, moisture, and corrosive or hazardous fumes.

### General Considerations

Fuses and circuit breakers should be capable of safely interrupting the maximum short-circuit current that could be reasonably expected at the point installed. Prior to the selection of any equipment, the short-circuit service at each point in the system should be calculated. If future increases in plant supply may ultimately affect the short-circuit cur-



Inside surface of inert gas tungsten arc weld root bead, "U" bevel, with "free-flowing" inert gas back up, is uniformly smooth.

# Here's How *Pittsburgh Piping* uses Inert Gas Tungsten Arc-Welding on Turbine Piping

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PP-7

rents available at any point, it is wise to allow for this eventuality in the beginning.

The system itself may be grounded at all neutrals, though this is yet a controversial subject. All substations and equipment frames should be grounded as should be distribution cabinets, bus framework, and utilization equipment. Substation grounds are particularly significant, and should always be in the order of 0.5 ohms or less.

If a lightning problem exists, lightning arresters should be installed and well grounded. Location is particularly significant. Protection should be afforded at each piece of equipment exposed unless expert advice deems this unnecessary. Outdoor primary equipment is particularly vulnerable to lightning, especially if served by overhead lines.

Power factor correction may be necessary, especially where the power load constitutes the major portion of the total plant load and is largely of an inductive character. The cost of installing power factor correction equipment should be balanced against the potential savings in the electric power bill. The electric utility concerned will generally cooperate in developing the necessary calculations.

### Selling the System

The designer of the electrical system may be so fortunate as to be responsible only for the system design, turning his cost estimates and plans over to someone else to sell to client management. Many engineers, however, are also burdened with selling client management on the need for spending money.

Here are a few simple rules for successful presentation of recommendations:

¶ Have a basic proposal — this should be the simplest, and least expensive system that will meet the basic project requirements.

¶ Have a better system — with some extra features that you feel are advisable and for which client management may be willing to pay.

¶ Have a best system — the maximum that you feel is economically justifiable and that incorporates the desirable features that make it the kind of a job you would prefer if you had the full power of decision.

¶ Present the requirements with costs in a written report, expressed in language that management can understand. Electrical engineering technology may not be well understood in the "front office," but business management is. Rest assured that a well-planned, economically sound proposal can be identified as such. Make sure that your program does.

If approval is not forthcoming, reappraise your sales technique. Perhaps your program was not properly presented, or did not fit conditions. In any event, after assuring yourself of the economic soundness of your plan, re-direct your attack. You will have an excellent chance of selling your program if it is sensible and if it is presented correctly. ▲▲

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**Liability Insurance**

—*Starts on page 46*

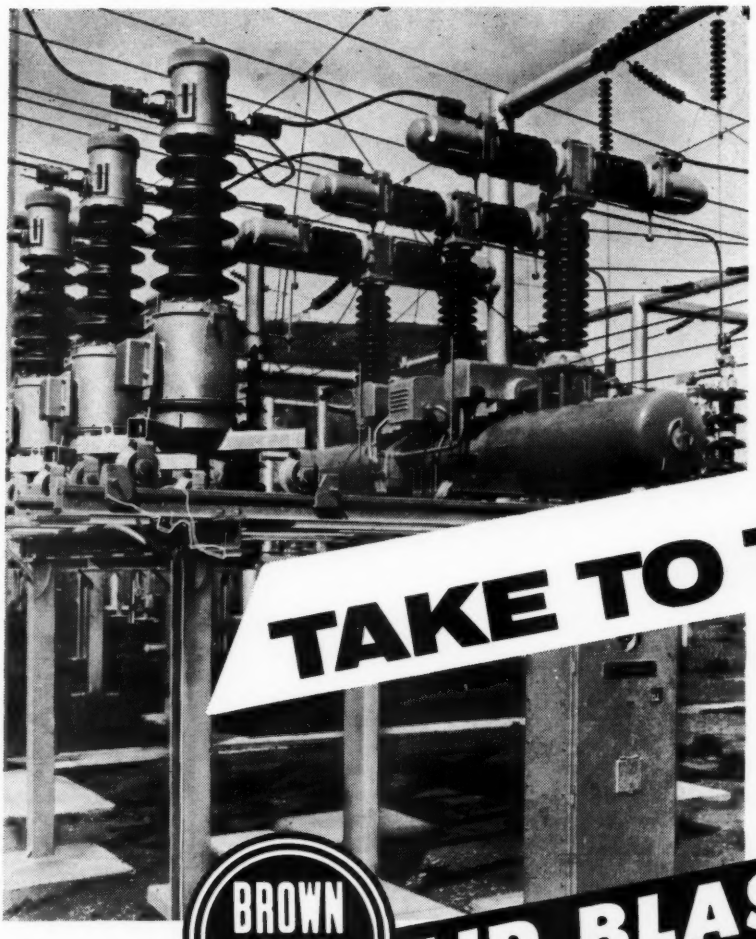
arranged, and a consulting engineer, if he is willing to pay a high rate, can probably get a Lloyds coverage drawn up exactly as desired. Lloyds are by no means wide open underwriters, but they can approach an insurance problem in a different way from American insurance underwriters. Lloyds is not an insurance company but a series of committees or groups, each with a head underwriter, and these groups bank on their Chief Underwriter to make them some profit. A group can go broke, as they have, and Lloyds would never be affected, as new groups are always available.

The American insurance underwriter usually represents a stock insurance company, and he is not permitted to put the assets of his company on the block. So he is not a gambler. There has been a constant, progressive expansion among American insurance underwriters to offer new, varied, and broader contracts, but these are still based on statistical principles.

There is a great deal of study being given at this time to the subject of "Engineers' Professional Liability Policy," and to liability policies for architects, authors, newspaper publishers, and all people subject to possible lawsuits from unintentional errors, but all underwriters agree that the writing of such insurance will be slow in coming.

Where such policies have been written, they do cover the engineer anywhere in the world for negligent acts, errors, or omissions occurring during the policy period, or any claim or suit commenced in this country within two years after the policy has expired. Naturally, the policy does not cover any fraudulent or malicious acts, nor any injury or property destruction intentionally caused. It does not cover any employee of the engineer. The Texas type of policy specifically excludes "loss and expense for additions to remodeling, demolishing, or rebuilding of any structure as a result of error or omission in professional services, which error omission does not result in an accident." This does not mean that some underwriter will not waive this for additional premium consideration, but there is no tendency towards enlargement of this provision.

Even if insurance companies were to decide to offer engineering liability policies on a large scale, even if every local agent were encouraged to "go out and sell" such policies, there still remains the problem of professional engineering ethics. This problem of ethics and personal responsibility is for the professional engineers to decide. ▲▲



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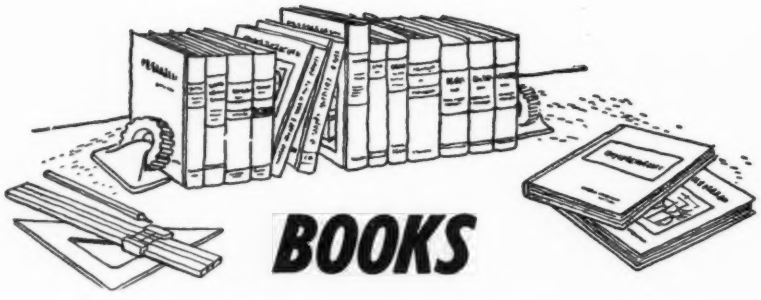


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NUCLEAR GEOLOGY, edited by Henry Faul; John Wiley and Sons, Inc.; 414 pp; $7.00.

*Reviewed by L. M. Atlas*
*Armour Research Foundation*

This volume is an excellent survey of the latest developments in the application of nuclear phenomena to geologic problems. Among the ten major chapters, the following may be of special interest to consulting engineers: "Fundamental Considerations, Instruments, and Techniques of Detection and Measurement," "Uranium and Thorium," "Geophysical Exploration by Nuclear Methods," and "Determination of Absolute Age."

Other chapters consider such subjects as rare gases and fission in nature, heat from radioactivity, the interaction of radioactivity and hydrocarbons, the abundance of the various isotopes of potassium, and the effect of radiation on the structure of minerals. As noted in the preface, little consideration is given to the stable isotopes in this volume because of the forthcoming publication of two other books specializing in this subject.

Because of the symposium form of this book, the presentation is authoritative and stimulating — at some expense in comprehensiveness and continuity. The individual sections are written in varying detail, but in all cases numerous references are provided. Mathematical theory is held to a minimum and applications to geologic problems are stressed throughout the book. On the other hand, speculation is not suppressed, as evidenced by incorporation of a chapter by Dr. Harold C. Urey titled "The Origin of the Earth."

All things considered, *Nuclear Geology* is a useful and interesting survey as well as a thorough guide to the literature for those who have a professional interest in the geologic sciences.

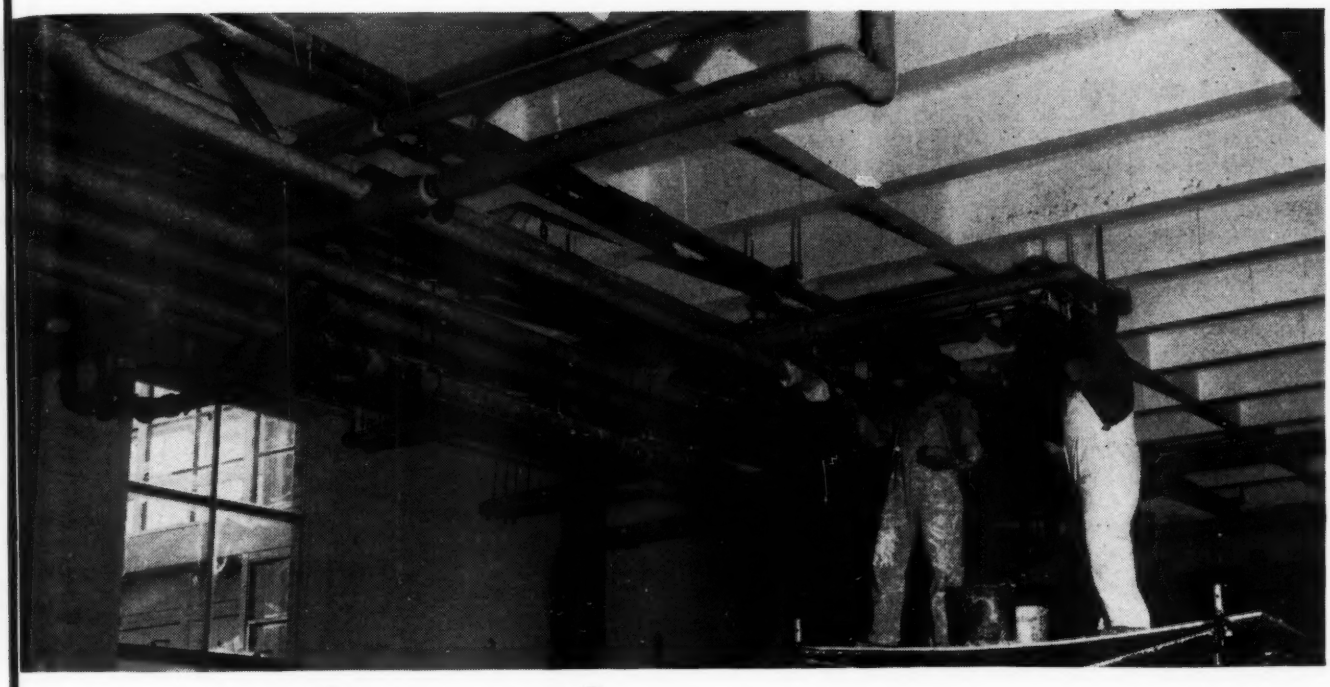
•

PATENT FUNDAMENTALS FOR ENGINEERS, by Henry K. Leonard; Pelex Publications, Inc.; 39 pp; $2.00

*Reviewed by Melvin Nord, P. E.*
*Patent Attorney*

In this little book, or pamphlet, or manual, or something, the author dedicates to the engineering public his ideas about patent fundamentals (without benefit of copyright). It is written in extremely simple style, so that it's more like reading "talking" than reading "writing." In the few pages that the author has allowed himself (and they are pretty small pages at that), he has found room for several pages of figures, a number of "homey"-type anecdotes, and some apparently humorous patents.

The book opens with a bang: "Now of course, we think that you ought to get as many [patents] as you can because that earns our living for us." It goes on from there to explain what a patent is and how it can be obtained — using such language as: "The other special classification I find of particular interest because it deals with a hobby of mine .... Plant patents are not only interesting, but I think they are very beautiful .... In order for a legal action to go ahead somebody has to carry the ball. Somebody has to talk first. In the



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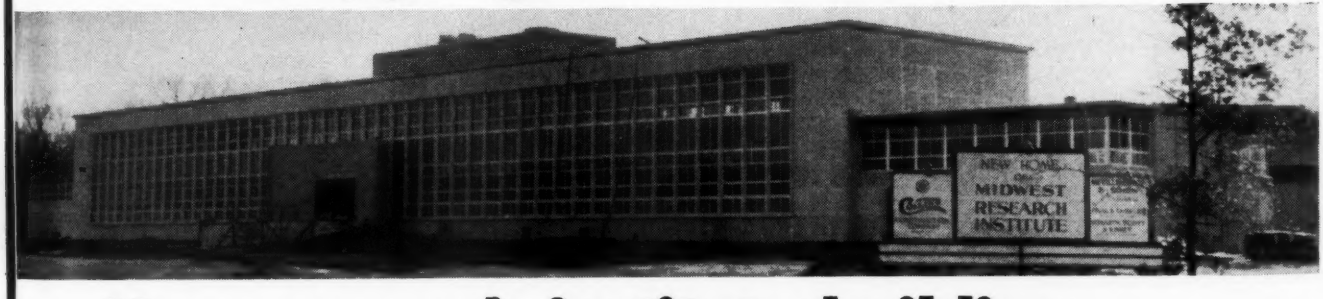


## New research institute building . . .

Take a good look at one of the country's most modern research institutes, soon to be completed in Kansas City, Missouri. It's the new building of the Midwest Research Institute, a non-profit organization that in the last decade has made outstanding contributions to the development and growth of midwestern industry and agriculture.

Heated piping in the new M. R. I. building* is insulated with G-B Snap*On, the new one-piece molded pipe insulation of fine glass fibers. Highlight features of Snap*On are its superior thermal efficiency, extreme ease of application, and its rugged durability. Lightweight Snap*On, in 6-foot sections with a single seam, were snapped on the pipe in a fraction of the time it takes to apply conventional segmented insulations. There was virtually no waste or breakage, for Snap*On is a rugged, resilient material that will not chip, flake, break or crumble.

Snap*On is available in sizes from ¾" to 33", and in varying wall thicknesses. If you have a job on the boards that calls for insulation of chilled or heated piping where temperatures do not exceed 350°F., see Sweet's File (Architectural) for complete data on this revolutionary new pipe insulation. Or better yet, call your local G-B distributor who maintains local stocks of Snap*On. He's listed in the Yellow Pages in 57 cities.

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law we say he has the burden of proof.... So if you're the first applicant you just sit back and relax while the other fellow tries to prove that he invented before you did..."

After a while, the author is reminded of some funny incidents. Naturally there is one about an inflatable brassiere. He finally gets around to the laying of eggs: "When I was a small boy, I lived in a small town and my mother used to get her eggs from one of the farmers...."

The climax is reached in the final act (or chapter), in which the author points out that patents affect engineers (as well as chickens).

●

ANALYSIS OF STATICALLY INDETERMINATE STRUCTURES, by John I. Parcel and Robert B. B. Moorman; John Wiley & Sons, Inc.; 571 pp; $9.50.

*Reviewed by Robert L. Janes*
*Propulsion and Structural Research Department*
*Armour Research Foundation*

This book is planned as the first of a two-volume treatise on the theory and application of statically indeterminate structures. This first volume is devoted to a presentation of the basic theory, together with its application to the more commonly encountered structures. These include continuous beams and trusses, single and multi-story rigid frames, secondary stresses, arches, and a rather extensive treatment of suspension bridges.

About half of the work is given over to development of basic theory. This portion may be lacking in interest to those practicing engineers who deal infrequently with indeterminate problems. On the other hand, it may be found to be quite useful as a refresher for those who only occasionally skirmish in this field.

The second half of the book contains a number of worked examples which should be useful to most engineers in practice. The examples are worked out very methodically, according to the best office procedure. The fact that the senior author is himself a consulting engineer of long standing undoubtedly is a factor which has led to precise presentation.

Both the slope-deflection method and moment distribution are thoroughly discussed and applied to a number of examples. Exponents of either method can therefore benefit equally. "Automatic" sidesway provision is included in treatment of rigid frames by moment distribution.

The authors mention in the preface that the second volume is expected to include more complex and less frequently encountered problems such as tall building frames, shallow arches, dynamics of suspension bridges, plate and shell structures, and space frames. ▲▲